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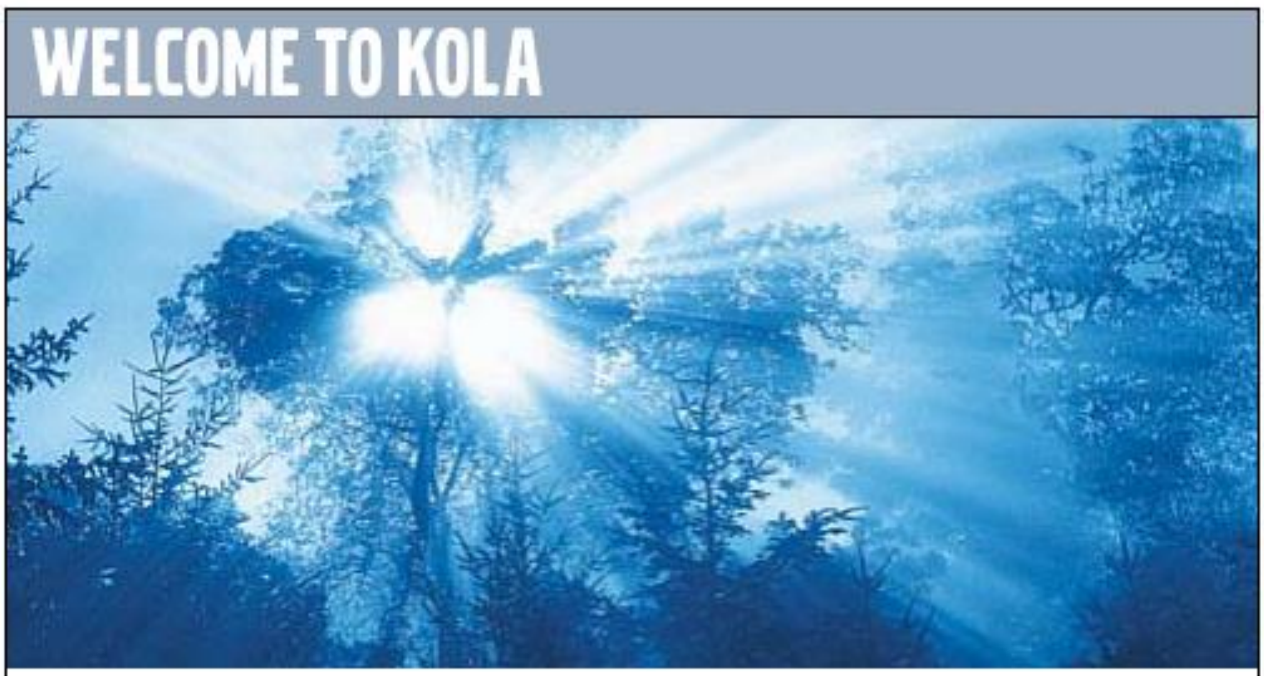

Impact of Usability on Process Lead-time in Information Systems

Master of Science Thesis in Software Engineering

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[Cover:
Welcome page of the KOLA system (see section 3).]

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Abstract

Technological advancements have started to demand the need for information systems to survive in the business world. There is an inherent need to be fast and efficient to conquer the market. In order to reduce time to market there is a need to shorten the lead-time in design and development process of products. Simply, lead-time is a significant performance metric for a product development organizations having information systems. It is important to explore the factors which affect the process lead-time in information systems and the objective of this thesis is to explore the impact of one of these factors which is usability. This thesis presents a case study, involving qualitative and quantitative studies, performed on a leading Swedish automotive company which uses information systems for their design and development process. Thus, impact of usability on process lead-time in information system was studied.

Keywords- usability; level of experience of users; information systems; process lead-time; software engineering; impact

Contents

1

Introduction

Competition today has conquered the market, and companies are constantly under the pressure of delivering new products as fast as possible. In this situation, it is very important to eliminate any potential obstacles that might cause delay in design and development process and affect time to market. In design and development process, lead-time reduction is an important subject [45]. A short lead-time through a process chain results in a higher productivity and thus increases the overall added value within a given period of time [39].

Companies seek to create business entities that are leaner, more flexible and more responsive to a rapidly changing business environment [60]. In this regard, Ragowsky et al. [55] point out that companies can benefit from the use of information systems to lower their response time to market demands. Each of these information systems possesses their own user interface and infrastructure, constructing the need to consider the impact of usability. Usability simply means 'quality in use' [35]. It is related to both system performance and user performance, and is achieved by designs that take into account the physical and psychological characteristics of users, the tasks they are likely to accomplish, and the environments in which they work [3]. As a result, usability directly or indirectly influences and determines the time users take to make a decision or take an action. Thus, it is important for companies to value usability factors and concentrate on learnability and memorability, efficiency of use, ability to avoid and manage user errors, and user satisfaction [33] to shorten the lead-time in their design and development process. In addition, new users of an information system need to learn and adapt to the system as fast as possible and experienced users are expected to perform fast and make few or no mistakes; therefore, it is also required to consider the relation between experience level of the users and impact of usability on process lead-time in information systems.

There have been several studies about how usability of information systems has an important role for companies in acquiring the market share [4, 31] or the relation between impact of usability and level of user's experience [1]. However, to the best of authors' knowledge, there has not been much research conducted to study the impact of usability and its relation to level of user's experience on design and development process lead-time and time to market.

To investigate the impact of usability on process lead-time in information systems, we made a case study at Volvo Group on their information system called KOLA (see section 3). Impact of usability was studied by conducting 29 interviews and 17 think aloud sessions, collecting 73 survey responses, performing 5 document studies and attending a training workshop. Collected data was analyzed to investigate impact of usability on process lead-time in information systems and identify to what extent the experience level of the users impact usability on process lead-time.

This thesis is structured as follows: in section 2, we present the background and related work. In section 3, we introduce the case study company and the information system. In section 4, we describe research methods followed by section 5 that explains the results of our research and the main discussions are presented in section 6. In section 7, the thesis ends with a conclusion and future work.

2

Background and Related work

This section presents the theoretical background and review of related literature of usability and its impact on process lead-time in information systems. In the following section, the background is introduced followed by the related work section.

2.1 Background

User friendly software is gaining high popularity in the market [17]; therefore, it is important to build and produce usable software. Researchers and industry experts have recognized usability as a crucial aspect towards developing usable software [11]. Usability is a key property of information systems, thus, any system designed for people to use should possess high usability [11, 26]. Usability is a system attribute that manifests itself when users can accomplish their tasks effectively, efficiently, and with a high level of satisfaction [28]. Systems with poor usability can result in long task times, high error counts, large support costs, long training times, and user dissatisfaction [28]. Hence, it is very important that systems have good usability and communicate with users in such a way that preferences or necessities of each user is reflected thoroughly and thereby users can interact with systems in high performance and reduce process lead-time.

Information systems are developed based on company's unique protocols to provide flexibility and control over the development process and its results [18]. The logic of these systems could be unfamiliar to users; therefore, poor user experiences in information systems and the consequent inefficiencies in these systems have a downstream impact on the user's performance [17]. Considering this matter, success of information systems becomes more dependent on their usability and the ability to provide accurate content and useful services specifically tailored to end users, according to their requirements [16].

2.2 Related Work

The benefit of software systems has increased nowadays which raises concerns toward the impact of usability. This section presents the related literature of usability and its impact along with the influence of level of experience.

Impact of usability in safety critical systems

There are many systems that are used for managing and handling critical issues, where the behavior of the human operator has a significant impact on overall system safety [20]. In safety-critical systems behavior becomes more time-critical. Time dependencies and temporal constraints are an important aspect of action, and failure to meet them leads to an important class of human errors; many of the errors associated with safety critical systems have a significant temporal component [20]. The results show that usability is the main factor affecting users' performance [4]. Dealing with temporal deadlines and concurrent activities in safety critical systems is tightly related to how well user can interact with the system, highlighting the impact of usability in these systems.

Impact of usability on sales and revenue

Usability also has a significant impact on marketing websites by increasing user satisfaction and sales in e-commerce shopping sites. The design quality of these websites is a key factor in determining the success of their e-marketing product strategy [4]. Poor product usability may have a negative impact on various aspects of the organization, and may not allow users to achieve their goals efficiently, effectively and with a sufficient degree of satisfaction [4]. Research has established that systems with high usability can provide several advantages; reducing costs and user frustration and hence increasing sales and user loyalty [31]. Therefore, usability plays an important role in e-marketing strategy and business success.

Relationship between usability and level of user’s experience

In addition, there have been several researches on how level of users’ experience and usability of information systems are related. Research has shown that user patterns of information system use change significantly as their levels of experience with the system increase [71]. For instance, Alexander [1] found that experienced users were able to complete the tasks more quickly than novices users; however not more accurate. They believed this is due to impact of usability in information systems and there is a need to focus on preventing errors so that users with different level of experience can all benefit. It is important to understand the relationship of level of experience and usability factors so that information systems can be designed more effectively during software development process.

Usability and software engineering

There are a number of related works that imply usability has an impact on software development process. Natalia Juristo [34] argues that usability has an impact on software requirements and design. She claims that usability is not confined to the system interface and can affect the system's core functionality. The improvements in system usability involve modifications beyond the interface, specifically, to the design of some software components and, therefore, to its core [34]. Considering this analysis, she claims that usability should be brought forward in the development process and considered in software requirements in order to define and evaluate its impact on design as soon as possible [33].

Usability, process lead-time and business

New product development is an important business process and constitutes a major contributor to the business excellence of any manufacturing firm [45]. Information systems are an integral part of these business processes as they support in managing the data, people and processes. Designing an optimized new product development process using such information systems is an important problem in itself and is of significant practical and research interest. There are several researches, which strongly prove that, usability influences the factors affecting the success of a business [7] which predominantly carry over to the process lead-time. Also, researches show that lead-time is an important performance metric for a product development organization [45]. These researches conducted as discussed above, state that reduced process lead-time improves customer's satisfaction and value for money. However, how usability impacts the process lead-time in information systems is unknown.

3

Case study

3.1 Volvo Group

This chapter narrates an in depth view of the case company under study. Volvo Group is one of the leading manufacturers of trucks, buses, construction equipment, and drive systems for marine and industrial applications. They also provide complete solutions for financing and service. The Volvo Group, with its headquarters in Gothenburg, employs about 100,000 people, has production facilities in 19 countries and sells its products in more than 190 markets [68].

3.2 KOLA

This case study was conducted on an information system used in Volvo Group called KOLA (KOnstruktionsdata LAstvagnar). KOLA is a PDM (Product Data Management) system which was originally built to create an interface between the design and production in 1981. The system is used by about 11,000 users from different departments across Volvo Group. There was a major reconstruction of KOLA around 1999 and the current user interface is the outcome of that evolution. KOLA is based on Volvo Group PDM Logic which is the framework used to describe and communicate a range of technical product offering and corresponding design solutions (Volvo PDM Guidelines). Volvo Group PDM Logic is based on three cornerstones: Product Logic, Business Logic and System Logic. These cornerstones and their relation to Volvo Group PDM Logic are described in figure 3.1.

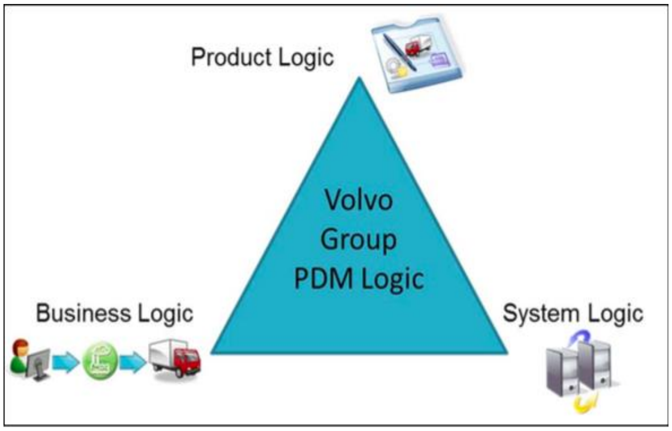

Figure 3.1: Volvo Group PDM Logic definition.

The central core is the PDM Logic and around it are the three corner stones:

- **Product Logic:**
  The product logic is how the vehicle or the trucks is built out of components that are needed to manufacture a truck and the way the components are documented in the system.
- **Business Logic:**
  The business rules are supported by the KOLA system, e.g. Standards, rules, methods, Instructions and the Project Handbook. Business logic can also be described as the information flowing back and forth between the main processes, based on Volvo Group PDM Logic.
- **System Logic:**
  The system logic is the way the KOLA-system and other related systems used in factories for building vehicles are built and how they operate and interact.

In the recent years, there have been several business reformations within the Volvo Group. However, the PDM Logic has held strong functioning perfectly to fit every situation the company has been through. This is due to the fact that KOLA holds a unique quality to remain rigid to business rules yet flexible to adapt to the needs. This special characteristic of the logic are effectively maintained and explained in the KOLA interface. The KOLA interface is predominantly window based and occasionally having to navigate to web pages or other systems outside it. It is built on Java and COBOL. There is a strong belief that empowering KOLA with advanced technology and modern aesthetics, there is a good possibility to reduce the process lead-time resulting in improved business.

4

Research Approach

This section describes the method in which this research was conducted. First, the purpose of this study and the research questions are presented. Next, research methodology is explained and it is followed by a description of data collection approaches. This section ends with explanation on data analysis and validity threats.

4.1 Research Purpose

The purpose of this study is to understand what impact usability has on process lead-time in information systems and investigate its effect with regard to the level of users' experience. Following are the research questions that we have attempted to answer in this study.

RQ1: What impact does usability have on process lead-time in information systems?
RQ2: To what extent does the experience level of the users, impact usability on process lead-time in information system?

4.2 Research Methodology

This thesis reports a case study on information system. Case study was mainly chosen as the research methodology in this thesis, as it is the most widely used research methods in information systems research [14]. It is well suited to understand the interactions between information technology-related to innovations and organizational contexts [14, 52, 43]. Thus, researchers studied and evaluated the usability of the existing information system, critiqued the system and examined it in way to identify the causation of the existing lead-time in the process of design and development [67].

This thesis was conducted as a single case study where the focus and case is an information system within the organization (Volvo Group, see section 3). The phenomenon being investigated is the impact of usability on process lead-time and its effect with regard to level of users' experience. Consequently, the unit of analysis is the design engineers who use KOLA (see section 3) in their daily work.

Moreover, the purpose of research is to generate theory and prove it [51]. It can be achieved by either qualitative data collection which is concerned with words and meanings or quantitative methods which are concerned with numbers and measurement [70]; or sometimes combination of both. Since our study involves human behavior, verification cannot rest on intuition, numbers, argument, or opinion [51]; therefore, it was decided to base our verification on both data collection methods. As case studies typically combine data collection techniques such as interviews, observation, questionnaires and document analysis [14], it seemed to be the best fit for this thesis. Thus, several methods were combined with a desire to effectively investigate and communicate the findings of this case study with a stimulating and valuable report.

4.3 Data Collection

Data is collected in order to answer the research questions [57]. The data points collected in this thesis investigated both human aspects and technological possibilities. Gall and Borg [23] state that a typical quantitative research is more numbers driven, positivistic, and traditional while qualitative research is often more naturalistic, ethnographic [19], subjective, or post-positivistic. Hence the researchers decided to adopt a triangulation [15] of both qualitative and quantitative data collection methods as they are complementary to each other. Triangulation is the combination of methodologies in the study of the same phenomenon. It is also believed that it captures a more complete, holistic, and contextual portrayal of the unit(s) under study [32]. This triangulation of methods was chosen with one buried basic assumption that the effectiveness of triangulation is based mainly on the premise that the weak points in each of the methods will be countered by the strengths of others [32]. It is assumed that multiple and independent measures do not share the same weaknesses or potential for bias [56, 32]. Due to the above findings, the data collection in this thesis was a combination of document study, workshop, interview and think aloud methodologies categorized as qualitative research and survey methodology categorized as both quantitative and qualitative research. The data collection methods and their accomplishment sequence are depicted in Figure 4.1.

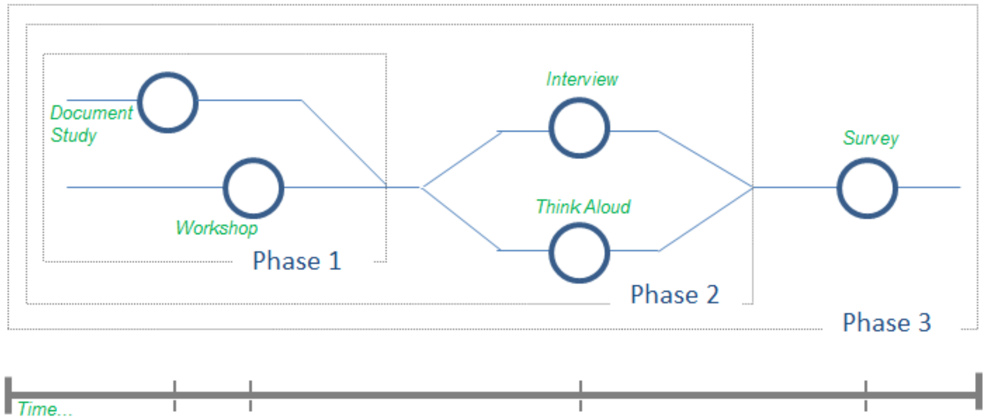

Figure 4.1: Temporal presentation of methods used in data collection approach.

As it can be observed in figure 4.1 the data collection was done in three phases. In Phase 1, researchers started data collection approach by conducting document study (see section 4.3.1) and attending a workshop (see section 4.3.2). These two methods helped the researchers to collect primary data about the business rules and the logic of the system. Studying and analyzing these data provided a quick insight on what to expect in this study and how to proceed further. In Phase 2, the findings of Phase 1 were used as inputs to originate the interview (see section 4.3.3) and think aloud (see section 4.3.4) protocols. Data gathered from these methods provided a step forward to understanding the problem and answering the research questions. To validate our first findings and to collect more data, outcome of the two previous phases served as inputs to Phase 3 i.e., the survey (see section 4.3.5). At the end, findings from all data collection methods were used to provide answers to the research questions.

From the result of the document study, researchers identified that there were about 11,000 potential KOLA users. Also, they realized that the system under study was large and had many functionalities and criticalities, which lead the researchers to narrow down the scope of the study. This was achieved by identifying a target group of about 3,000 users based on 3 criteria. Firstly, the groups that yielded a good deal of business value. Secondly, the groups of people who were important to the company in the context of this study. Lastly, the groups that had the highest number of people with similar roles. By this mean, the data collection process was focused only on the target group.

In addition, researchers categorized the target group into to three types of users; new users, experienced users and key users. New users were those who used the KOLA system less than 90 minutes a week with less than a year of experience in using KOLA. Those who spend more time every week and had more than a year of experience were considered as experienced users. Key users were a portion of these experienced users whom others contacted for support and help with the system. These three categories were made from investigations to obtain a better control over data collection process.

4.3.1 Documents Study

Documents study was conducted as the first step in data collection process as they provide the researchers with an overview and audience for the case study. The initial study began by reading about PDM systems on the internet, to achieve a better recognition of these types of systems and then it was followed by reading KOLA related documents found in the company's archive. These documents were carefully studied and analyzed by both of the researchers. The researchers started by studying documents about system logic, business logic and product logic known as PDM Logic (see section 3.2). 3 main documents in this area were studied which provided the researchers with an insight to the underlying business logic and enabled them to gain a good understanding of the purpose and importance of the system. In addition, these documents provided an idea on the criticality of the system in business and clarified the type and number of users involved. After gaining knowledge about the system logic and its business rules, an attempt was made to study 2 documents related to system development. These artifacts of interest helped the researchers to get a good analysis of the developers' pathways, decisions and choices as they have proceeded with the development of the system [66].

Comprehensively, all the documents guided the researchers through the process of finding the most important background information and gain a perspective about the system. In addition, small clues about potential problems in the systems were detected by the researchers. The researchers were able to identify the complex areas and get the big picture and understand the context of KOLA. These findings supported researchers to identify the target group. Also, the findings provided an input to interview and think aloud protocols.

4.3.2 Workshop

Researchers attended a two-day - 8 hours - training workshop held by the company. The workshop covered steps and processes involved in the main business workflow. During the workshop every attendant had access to the system so they were able to practice the learning materials and the exercises. In this process, the researchers were able to become familiar with how the system works. This provided an opportunity for the researchers to experience learnability, efficiency, memorability and other usability factors [49] of the system as new users themselves. Also, they were able to observe other new users while exploring and learning the system to identify the problem areas and parts that were complex or hard to learn.

4.3.3 Interviews

Semi-structured interviews were used as the interview structure in this study to elicit not only the information foreseen, but also unexpected types of information [59]. To conduct interviews, the following six stages was considered: (a) selecting the type of interview; (b) establishing ethical guidelines, (c) crafting the interview protocol; (d) conducting and recording the interview; (e) analyzing and summarizing the interview; and (f) reporting the findings [54].

In this study, 29 subjects were interviewed. In order to obtain a distribution of viewpoints, subjects who possessed different roles and responsibilities were selected from the target group. The selected subjects were invited by email containing a short description of the purpose of the study and the expected timespan of the interview session. Date and place of the interview was set according to subject's preference by follow up emails.

To assure quality of the interview protocol, two members from the industry with sound knowledge of the system, checked the validity of the interview questions. It was important to make sure that the questions are relevant, clear and detailed to an appropriate level. Each of the questions allowed the researchers to dig deep into the experiences and/or knowledge of the participants in order to gain maximum data from the interviews [65]; therefore, distinctive set of interview questions were conducted for each user category (Appendix A). Trend of the outcome from primary interviews and experience gained through each meeting were used to make minor refinements to the interview protocol.
Interview meetings were arranged and booked beforehand and they were conducted during working hours and held in conference rooms at different Volvo locations (Volvo IT, Volvo GTT, Volvo Bus and Volvo Penta) in Gothenburg.
Two type of interview meetings were conducted; long-interview and short-interview. 19 subjects were interviewed for 60 minutes considered as long-interview and 10 subjects were interviewed for 10-15 minutes considered as short-interview. Both researchers participated in conducting the interviews. For each meeting one concentrated on taking notes and the other focused on asking the prepared and follow-up questions. Interview sessions initiated by giving thanks to subjects for their support and continued by an introduction to the purpose of the interview and objectives of the study, terms of confidentiality and brief explanation of the interview flow. The whole interview session was audio recorded upon gaining permission from the subjects. The interview sessions were structured according to the Pyramid model which begins with specific questions and continues with open ended ones [58]. At the end of the session, the subjects were asked for suggestions and comments.

After each interview session a summary list was written based on the taken notes and the knowledge gained by the researchers. Also the recordings from the interview session were transcribed into text for further analysis. In some cases transcripts were sent to subjects to be reviewed and confirmed to increase validity of the collected data. By this mean, the interview subjects had the chance to point out if they did not agree with the interpretation of what was said or if they simply have changed their mind and want to rephrase any part of the answers [58].

4.3.4 Think aloud

Think aloud method was used to gather insights about the design of the system being studied. This method helped the researchers in the process of discovering usability problems while they occur, determine why a problem occurs, learn about how users feel about the design and learn how users approach tasks [25].

17 of the long-interview session were followed by a 30 minute think aloud session, where participants were asked to say their thoughts aloud while performing some tasks. New users, who had little experience in working with the system, were given some predefined tasks. These tasks involved main processes of the target group's workflow. The experienced and the key users, who had more experience in using the system, were asked to perform their daily work and think aloud during the process. Both researchers participated in the think aloud sessions. One of them focused on observing the subjects and taking down notes which were compared and aggregated later to come up with unified results. The other researcher acted as facilitator during the sessions, describing the sequence of tasks to be performed and reminding the subjects to think aloud while they were performing. However, the researchers tried to be as unobtrusive as possible while the participants were performing their tasks to ensure that the participants are not constantly thinking about being observed [59].
After each think aloud session, researchers spend some time on listing the findings based on the taken notes and their observation.

4.3.5 Survey

The researchers decided to use survey method to identify and prioritize the issues of a system which was being used by a large target group, as surveys are said to be the most common technique to collect data related to large groups [66].

An online web survey was set up in the SharePoint system of the company. It consisted of 18 questions which were estimated to take 10-15 minutes to answer. Galesic and Bosnjak [22] found out that the completion rate of response to a survey is considerably higher when length of survey is about 10 minutes. Also keeping the survey shorter will help to ensure response quality and have more motivated and responsive respondents [12]. Therefore, researchers did their best to construct the survey in such a way that it did not consume too much time or energy from the participants.

Two types of questions were constructed for the survey, open-ended and closed-ended questions (Appendix B). Three open-ended questions were constructed as free text which gave the participants the opportunity to type their responses. The closed-ended questions were created as multiple choices, checkboxes and Likert scales questions to create quantifiable data. An attempt was made to make the questions specific, clear and unambiguous. The survey questions were verified for validity by two members from the industry with sound knowledge of the system. The first half of the survey contained demographic questions followed by general questions about the system and the second half of the survey was constructed with more detailed questions. The detailed questions were derived from the previous outcomes and they were based on inputs from the think aloud and interviews findings.

An effort was put into pilot testing, pre-notification, survey invitation, and reminder messages of online survey [10]. The survey was sent out to a smaller portion of the target group for pilot testing to detect any problems that were overlooked upon at the preparation phase. The participants were given pre-notification and they were informed beforehand about the survey and its purpose. Thereafter, they received an invitation email containing a link to the survey and the estimated time to complete the survey. They were promised that the responses would be treated anonymously. Also they were informed that the final compilation of responses would be available online.
The survey was made available for 2.5 weeks and had two reminders to fill it in. At the end of 2.5 weeks there were a total of 73 responses and the response rate was 49%. In the first attempt, the survey was sent out to 150 people. After a week's time, we had about 54 responses. A gentle reminder was sent to the rest and we had additional 19 responses. Further, the data collected from the survey was analyzed as described in section 4.5.3.

4.5 Data Analysis

In qualitative studies the data set is very large; thus, researchers needed to organize data, extract meaning, arrive at conclusions, and generate or confirm conceptual schemes and theories that describe the data [62]. Figure 4.2 represents the different times at which the data analysis was performed. Data from document study and workshop were analyzed simultaneously in Phase 1. The data from interview and think aloud methods were analyzed right after Phase 2 and survey data was analyzed at the end of Phase 3.

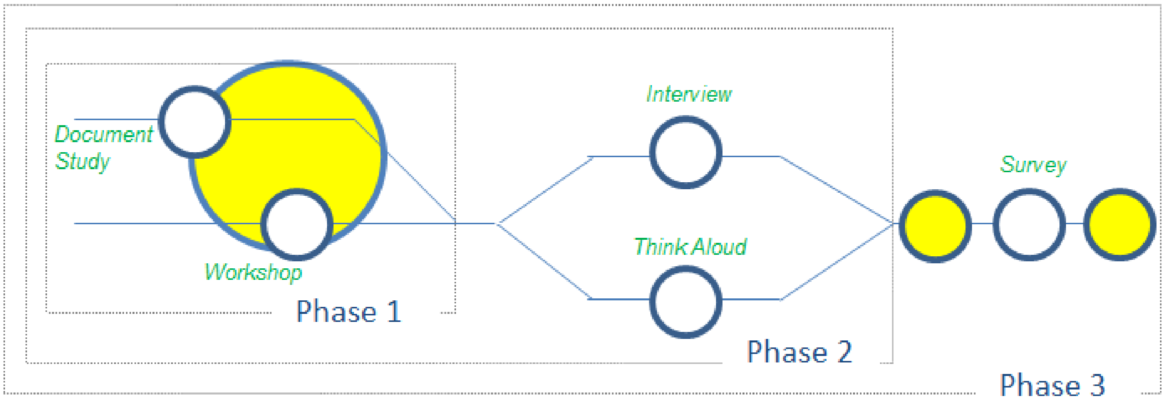

Figure 4.2: Temporal representation of data analysis process.

4.5.1 Data Analysis for Document Study and Workshop

In this study, data analysis for document study and workshop was done using qualitative content analysis. Researchers used this technique to identify and describe concepts and patterns by going through the collected documents and observations to scrutinizing them closely. [64, 41].

The researchers started by analyzing the preliminary documents which were gathered during the first set of data collection in the document study process. The document study was continued through data analysis process to allow researchers to identify complete and accurate areas of study, and perceive the big picture. This approach provided researchers with a better focus in gathering related documents.

Once the researchers studied the preliminary documents, they proceeded by generating a category scheme. In this thesis, the category scheme was developed in a close and iterative loop to identify the significant concepts and patterns [41]. The researchers were inspired by the step model of inductive category development proposed by Mayring [42] as shown in figure 4.4.

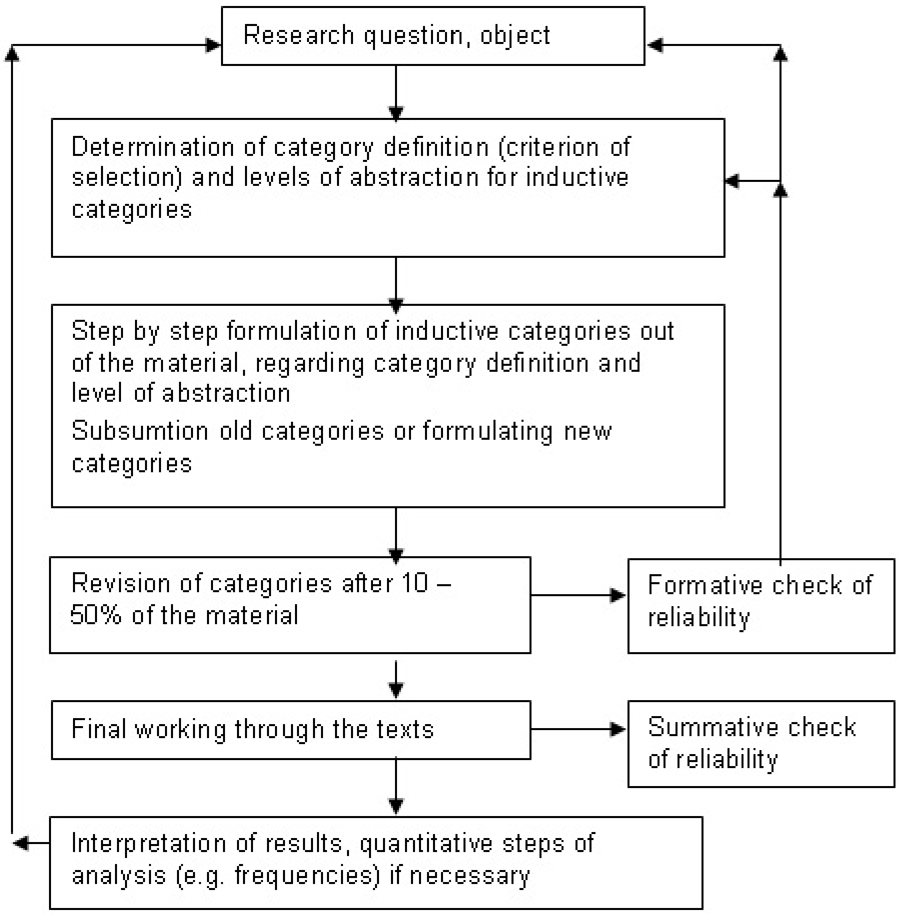

Figure 4.4: Step model of inductive category development [42]

The categorization was performed in a subjective manner where the researchers used memos from the documents under study and the observation notes from the workshop to record perceptions and formulations [41]. There were no prior categories and the research questions influenced the generation of categories in an inductive approach. The researchers began by tagging key phrases and text segments that corresponded to the research questions and were identified to be important concepts having similarities. This was done iteratively to compare the categories that emerged through this process [41]. After every iteration, categories were revised and refined to ensure reliability of the category. Also, at the end of one iteration researchers discovered that there was a need to collect new data. This iteration continued until all materials were analyzed, categories were determined and the levels of abstraction were decided. In the end, a final summative check to reliability was performed to verify conformance.

In this process, the researchers gained a good understanding of the PDM Logic, got a general perspective of the system and identified the problem areas. These analyses provided a good input to the formation of the interview questions and think-aloud tasks.

4.5.2 Data Analysis for Interview and Think Aloud

Data analysis for interview and think aloud method was based on Romano JR. et al. [57] approach. This approach consists of three major steps shown in Figure 4.4: elicitation, data reduction, and data display. Further, the data reduction step consists of selection, coding, and clustering sub-steps. Section 4.5.2.1 explains the elicitation step. Data reduction step and its three sub-steps are described in detail in section 4.5.2.2 and section 4.5.2.3 describes the data visualization step. Figure 4.4 depicts the process of data analysis approach used in this study.

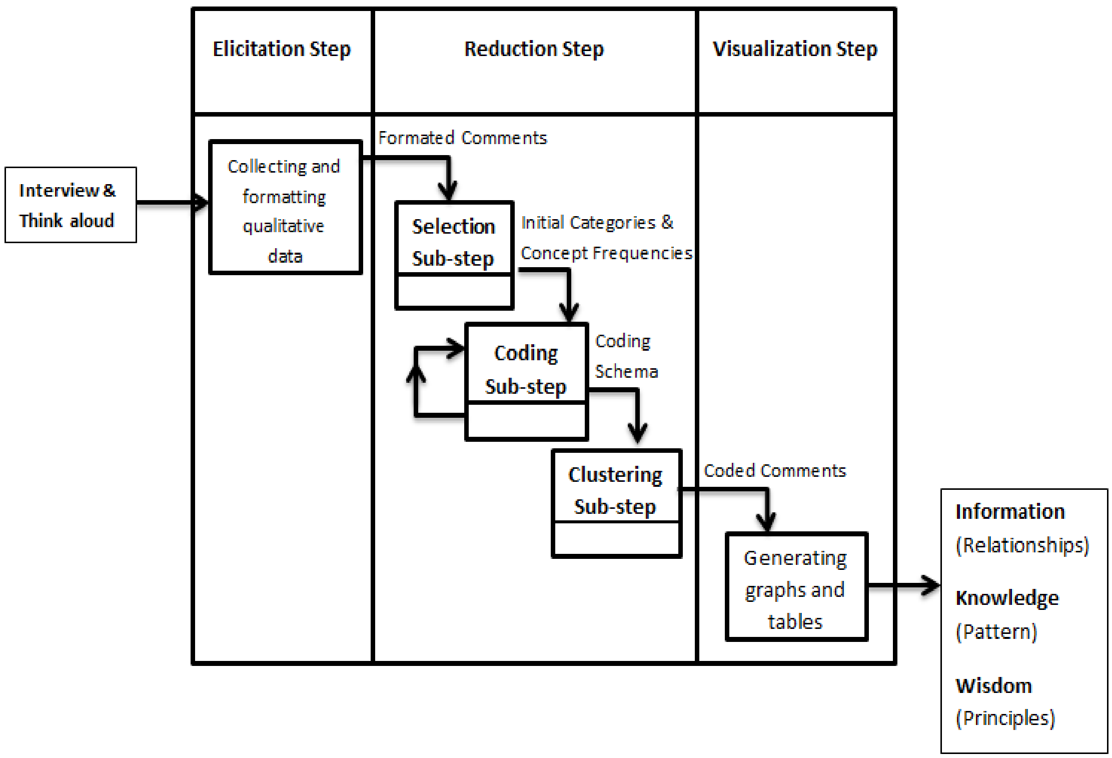

Figure 4.4: Steps in data analysis.

4.5.2.1 Elicitation

The act of elicitation is considered to be an important component of the research in qualitative studies [57]. In this step, researchers collected data and familiarized themselves with the data. During this process, researchers produced extensive notes while interpreting the interviewees' answers in the transcripts. These extensive notes along with the observation notes from think aloud method were imported into excel sheet as comments. In the excel sheet every comment was mapped to its source referring to which interview or think aloud session the comment belonged to.

The output of elicitation was a list of formatted comments that was analyzed through the reduction step (see section 4.5.2.2).

4.5.2.2 Reduction

Reduction is a critical step in this approach and it involved selecting, focusing, simplifying, abstracting, and transforming raw data to make it useful [57]. Codes and categories were derived from general theory, the research questions, usability concepts, and from the data collected [57].

4.5.2.2.1 Selection

Selection involved deciding on initial categories which involved developing category schemes and unique concept lists [57]. The researchers decided to generate categories according to five usability factors [49] and further break down the categories into 10 sub-categories based on usability heuristics [47] in order to perform analysis on the data that was collected from interview and think aloud methods. The heuristics were refined based on a factor analysis of 249 usability problems by Nielsen [47]. The researchers decided to map usability factors to usability heuristics to have a better focus on studying impact of usability on process lead-time in information systems.

4.5.2.2.2 Coding

Coding is the process of grouping the comments into the classes defined in selection to establish specific sets of codes for the categories developed in selection, derived from context reviews and based upon concept frequencies [57]. For this thesis, the researchers reviewed all the comments related to 29 subjects gathered in the excel sheet to identify common concepts. Initial Codes were generated based on grouping similar comments supported by multiple subjects. Each code was assigned to its related category and verified to ensure if the code and the category was coherent with each other. The process of generating codes was carried out through an iterative process. During each iteration, codes were created, renamed, re-categorized or removed. Codes with similarities were merged into one code and codes that covered wide range of various comments were split into different codes. The purpose of this step was to get an accurate representation of the data set.

4.5.2.2.3 Clustering

Clustering usually involves deciding which data to code and how to code them [57]. In this thesis, the comments from the excel sheet were clustered and mapped to the codes generated in section 4.5.2.2.2 by both researchers. One of them read the comments aloud and both of them decided on which code each comment is most suited to be clustered into. On reaching an agreement, the code was assigned to the comments in the excel sheet. The mapping was refined into context by careful selection of comments and codes that were to be clustered [44]. The idea was to focus on mapping the comments to the generated codes appropriately, such that it would be a reflection of the actual data. Researchers had in mind to create a new category called "Others" to tackle the possibility of having codes that do not match any categories; however, they were able to map all the generated codes to a certain category.

The output of clustering was a set of coded comments that was used to generate graphical or textual visualizations of the data based on the categories and the codes assigned to the comments.

4.5.2.3 Visualization

Visualization involves preparing organized, compressed assemblies of the coded comments from step 2 (reduction) that provides valuable conclusions [57]. Visualizations organize data into accessible compact forms in which analysts can identify patterns [57]. Therefore, the researchers decided to generate tabular visualizations to illustrate relationships, patterns, and principles within the coded comment sets and categories. These visualizations supported to derive results from interview and think aloud methods.

4.5.3 Data Analysis for Survey

There have been studies on using quantitative research methods to utilize some form of statistical analysis in reaching conclusions and presenting findings [2]. Also, statistics is a field of science that relates to the collection, analysis, interpretation or explanation, and presentation of data [40]. Therefore, these statistics are necessary in order to provide consistency and validity to the data, as well as to provide grounds for comparison with other studies and other data. Since, the data collected in phase 2 consisted of a great deal of qualitative information; it was decided to have statistical methods to quantify the qualitative data. The combinations of these two methods yield measurable, consistent, comparable and quantifiable results.

In this step of data analysis, the survey results were collected and analyzed to draw final conclusions. The researchers started by making a data analysis plan which consisted of analysis on graphs, statistical analysis related to closed-ended questions and the three step analyses (see section 4.5.2) related to open-ended questions. To analyze data, researchers studied the responses with the aim of answering the research questions and evaluating the findings from phase 2. In addition, to perform statistical analysis the researchers made an attempt to validate the sample size. They wanted to make sure that the sample is a convenient selection from the population so that statistically significant data can be calculated in a straightforward manner. This means that survey results are accurate within a certain confidence level and not due to random chance. 73 responses as the sample size and a target group of about 3,000 users as the population are the primary factors influencing the confidence level yielding results with a broad 12% margin of error.

As already discussed, convenient samples were drawn from the target population under study from the survey during data collection phase 3. The samples were non-parametric on ordinal measurement scale. Therefore, researchers decided to perform a Chi-square test (Appendix C) as it is frequently used in statistical analysis of experimental data and mostly used for nonparametric data in statistical tests [5, 36]. There is no accepted cut-off for the sample size; however, Bolboacă et al. [5] recommend that the minimum sample size to perform a Chi square test varies from 20 to 50. On this basis, 73 responses from the survey seemed as a suitable sample size for Chi square tests.

Benefiting from chi-square test, researchers determined the significant association between two variables. The significant correlation between the two variables was determined by a pvalue less than 0.05. For tests having less than 1/5 of the expected values smaller than 5 [5], pvalue of Pearson Chi square was read to determine if the correlation is significant, otherwise pvalue of likelihood ratio was considered [27].

Tests that were significant were further studied by running regression tests (Appendix C). Regression analysis was used to check the relationship between a pair of variables with regard to one of the variables carrying information about the other [13]. In this thesis it was interesting to know the impact of certain features in the system with respect to the level of experience of the user. Thus a cross tabulation was used to report the relationship between two or more survey questions since it can provide a comparison between the different concepts or groups of respondents who answered the survey questions.

4.6 Validity Threats

The validity of a study denotes the trustworthiness of the results, to what extent the results are true and not biased by the researchers' subjective point of view [58]. This study has adopted a classification scheme presented by Runeson and Höst [58] which is used commonly in software engineering. The scheme includes construct validity, internal validity, external validity and reliability in order to address the issues of reliability and validity. In this section the mentioned threats to validity are discussed along with the measures that were deployed to minimize their impact.

4.6.1 Construct validity

This aspect of validity reflects to what extent the research methodologies chosen in this thesis really represent what the researchers have in mind and what is investigated according to the research questions [58]. A multifaceted feature such as usability which involves human aspects eludes attempts to get objective measures [53]. Thus, the researchers decided to have a good triangulation of methods to collect data [32]. The methods used are a combination of qualitative and quantitative methods, as the advantage of one method could counter the disadvantage of the other methods. Therefore, a combination of document study, workshop, survey, interview and think aloud methodologies were used for data collection. The questions used in the interview and survey along with the tasks of think aloud protocol were validated by people from 2 different fields. 1 person from the academia and 2 people from the industry who have sound knowledge in the field were consulted during the formation of questions to have a good coverage, consistency and framework of questions. During the data collection, all subjects participating in different methodologies were promised absolute anonymity, both within the company and externally to obtain true reflection of their opinion. Also, the interview, think aloud and survey were carefully designed to keep them as short as possible. This information was delivered to the participants along with the invitation to increase the rate of participation.

Since the samples for study in interview, think aloud protocol and survey were conveniently chosen, the results were accurate within a certain confidence level and was not due to random chance.

4.6.2 Internal validity

Internal validity reflects on risks when causal relations are examined. When the researcher is investigating whether one factor affects an investigated factor there is a risk that the investigated factor is also affected by a third factor. If the researcher is not aware of the third factor and/or does not know to what extent it affects the investigated factor, there is a threat to the internal validity [58].

One of the objectives of this research is to study the impact of usability on process lead-time. There could be different factors that influence usability and different factors that influence process lead-time. All factors and their dependencies were not considered in this study. However, some factors that influence impact of usability such as level of experience has been considered in this study by performing statistical analysis to study the association between level of experience and usability factors.

In addition, the impact of usability on process lead-time was considered only with the consideration of information systems in this thesis. A better representative of the impact of usability on process lead-time would be to study it with respect to any type of a system.

The researchers were aware of "interviewer effect" while they conducted the interviews. Interviewer effect is about biasing the interviewee while collecting answers to questions in an interview by giving involuntary subconscious clues [53]. Thus, a conscious effort was made by researchers to not influence the thoughts or opinions of the interviewees.

4.6.3 External validity

External validity refers to to what extent it is possible to generalize findings, and to what extent the findings are of interest to other people outside the investigated case [58]. A threat to the generalizability of the findings of this thesis comes from the fact that interview, think aloud and survey studies were conducted on one information system in one company. However, for case studies, the intention is to enable analytical generalization where the results are extended to cases which have common characteristics and hence for which the findings are relevant [58].

Also, the fact that in this study results are categorized and mapped into five usability factors provides a good chance in generalization of findings; therefore, results from this study may benefit the investigation of other cases within similar contexts.

In addition, to alleviate the threat, participants under study for the interview, think aloud and survey methods were selected from different roles, departments and level of experience.

4.6.4 Reliability

Threats to reliability relate to what extent the data and the analysis are dependent on the researchers and to what extend the results are the same if conducted by another researcher [58]. The threat to reliability was alleviated by having two researchers conducting the study and reducing the risk of single researcher bias. In addition, all the steps of this research along with the research design artifacts, such as interview, think aloud and survey protocols and the findings were peer reviewed by an external researcher (university researcher).

Brink [8] claims that triangulation is one of the essentials for producing trustworthy and believable findings in qualitative research as it circumvent the personal biases of investigators and overcomes the deficiencies intrinsic to single-investigator, single-theory, or single-method study; thus, increasing the validity of the study. Considering this statement, the researchers were able to increase the reliability of the study by conducting four qualitative data collection methods: workshop, document, interview and think aloud study. Hereby, they were able to analyze the study of a single phenomenon and then validate the congruence among them [8]. Further, reliability was enhanced by conducting a survey study, performing statistical test and quantifying the qualitative data.

In addition, to increase reliability of the study, researchers tried to establish a clear chain of evidence of the research progress and steps [58]. Therefore, an attempt was made to digitize and store all the data that had been collected, such as notes from document study and workshop, audio recording, interview transcripts, think aloud observation notes and survey responses. However, due to non-disclosure agreement not all data, such as confidential information, can be shared for future external assessment.

Codes were generated from scratch during qualitative data analysis; however, they were mapped to pre-determined categories and sub-categories. To address such potential threat, researchers had created a category called “Other” to tackle the possibility of having codes that do not match any categories and avoid forcing the code into a specific category. All codes were mapped to a specific category without any problem and the “Other” category that was created initially was excluded at the end. Mapping the usability factor with usability heuristics of Nielsen [47] gave a richer and reliable set of data which helped to get holistic results and reduce the impact of inaccurate measurements

5

Results

This section presents the findings of this study after the data was analyzed in each phase (see Data Analysis). These findings are based on systematic experiments involving human subjects. The structure is organized with the aim of clearly answering the research questions presented earlier. First section is an introduction to results and it is followed by the next section which deals with findings for impact of usability on process lead-time in information systems, research question one. The last section is answers to second research question, answering to what extent the experience level of the users, impact usability in information systems.

5.1 Introduction

Interview and think aloud sessions together consisted of 29 participants. Out of these, 31% (9 participants) were female and 69% (20 participants) were male. In addition, 52% (15 participants) were consultants and 48% (14 participants) of them were employed by Volvo. Also, 38% (11 participants) were key users, 27% (8 participants) were experienced users and 34% (10 participants) were new users.

Table 5.1 contains the result from these interviews and think aloud sessions and it depicts impact of usability factors on process lead-time in information systems. In the table, five usability factors listed under “Category - Usability Factors” column are mapped to ten usability heuristics listed under “Sub-category - Usability Heuristics” column. Further, codes are listed under “Code” column and they are mapped to these categories and subcategories. These codes were generated in the data analysis phase and they are the components that have impact on process lead-time in information systems. Number of participants making comments related to a code in interview or think aloud sessions are listed under “#P” column and number of times a comment related to a code was mentioned is listed under “Stated” column. In addition, number of unique people whose comments referred to the impact of a

specific category or sub-category on process lead-time, is listed under "#UP" column next to category and sub-category columns. Each usability factor along with its sub-category and related codes is described in the following sections 5.2 and 5.3.
It can be observed from table 5.1 that, the most frequently mentioned categories, usability factors, are "Learnability" (29 out of 29 people), "Memorability" (29 out of 29 people) and "Efficiency" (27 out of 29 people) . Also, the table 5.1 illustrates, most frequently mentioned sub-categories, usability heuristics, are "Help and documentation" (29 out of 29 people), "Recognition rather than recall" (29 out of 29 people) and "Flexibility and efficiency of use" (27 out of 29 people). Further, it is depicted that the most quoted mentioned codes are "PDM Logic" (29 out of 29 people), "Visibility of objects, actions and options" (29 out of 29 people), "Right click shortcuts" (22 out of 29 people) and "Instruction of use" (22 out of 29 people). A more detailed presentation of other results are explained in the following sub-sections.

	Category - Usability Factors	#UP		Sub-category - Usability Heuristics	#UP		Codes	#P	Stated
1	Learnability	29	1.1	Match between system and the real world	5	1.1.1	Visual representation	4	5
						1.1.2	Reports	6	9
			1.2	Consistency and standards	10	1.2.1	Consistency in all windows	4	7
						1.2.2	Definite words, situations or actions	14	17
			1.3	Help and documentation	29	1.3.1	PDM Logic	29	44
						1.3.2	Notification on updates	3	3
						1.3.3	Help support	15	22
2	Efficiency	27	2.1	Visibility of system status	11	2.1.1	Notification messages - Visibility	3	3
						2.1.2	Comprehend notification messages	1	2
						2.1.3	Notification on system status	9	9
			2.2	Flexibility and efficiency of use	27	2.2.1	Multiple Windows	12	12
						2.2.2	Search	18	20
						2.2.3	Multiple Operation	6	9
						2.2.4	Built or change Functions / Features	11	20
						2.2.5	Extra steps to perform a task	7	9
						2.2.6	Right click shortcuts	22	28
			2.3	User control and freedom	3	2.3.1	Support undo and redo from mistakes	3	3
3	Memorability	29	3.1	Recognition rather than recall	29	3.1.1	Visibility of objects, actions, and options	29	43
						3.1.2	Instruction of use	21	26
4	Errors	25	4.1	Error prevention	12	4.1.1	Comprehend Warning messages	1	1
						4.1.2	System design for error prevention	13	15
			4.2	Help users recognize, diagnose, and recover from error	14	4.2.1	Comprehend Error messages	4	4
						4.2.2	System Controls and checks	15	17
5	Satisfaction	13	5.1	Aesthetic and minimalist design	13	5.1.1	Direct link or integration to other systems	8	12
						5.1.2	Handling Fields, buttons, tabs and matrix table in window / User interface	11	25

Table 5.1: Impact of usability factors on process lead-time in information system.

Survey had 73 responses for 18 questions related to demographics and KOLA. The results from demographic questions depict that 78 % (57 respondents) were male and 22 % (16 respondents) were female. 90% (66 respondents) of them were employed by Volvo Group and the rest (7 respondents) were consultants. Out of 73 respondents, 78% (57 respondents) fell into key user category (see section 4.3) and 22% (16 respondents) were non key users.

Further, figure 5.1 represent the average time each respondent spend in KOLA per week. It can be observed that 35% (26 respondents) are using KOLA for more than 20 hours a week in average. 15% (11 respondents) spend 30 to 90 minutes and 15% (11 respondents) spend 1.5 to 4 hours, in KOLA weekly. Also, 14% (10 respondents) spent about 8 to 14 hours in KOLA, every week. In addition, to have a better distribution of samples in all further statistical analysis, results in figure 5.1 were merged to create three groups: 1) A group of 26 respondents who spend average of 0 to 4 hours per week. 2) A group of 21 respondents who spend average of 4 to 20 hours per week. 3) A group of 26 respondents who spend average of over 20 hours per week.

Figure 5.2 illustrates the years of experience of each respondent in KOLA. It shows that 61% (45 respondents) have been working with KOLA more than 8 years. Also, 26% (19 respondents) have been working with KOLA for 4 to 8 years. In addition, to have a better distribution of samples in all further statistical analysis, results in figure 5.2 were merged to create two groups: 1) A group of 28 respondents who have been working with KOLA less than 8 years. 2) A group of 45 respondents who have been working with KOLA more than 8 years..

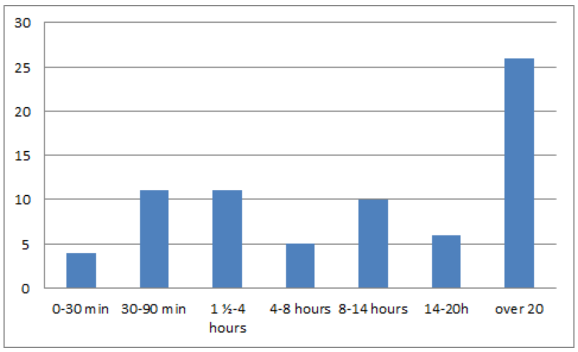

Figure 5.1: Average time spent in KOLA per week.

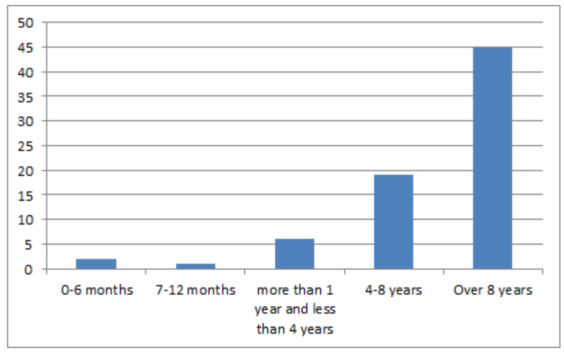

Figure 5.2: Years of experience of respondents in KOLA.

Figure 5.3 depicts the various roles and responsibilities of respondents. It can be clearly observed that the design engineers are the highest respondents with 32% (23 respondents). Design engineers are followed by DCN specialists (15 respondents i.e., 20%), project leaders (5 respondents i.e., 6%), project support (5 respondents i.e., 6%) and other roles (14 respondents i.e., 19%).

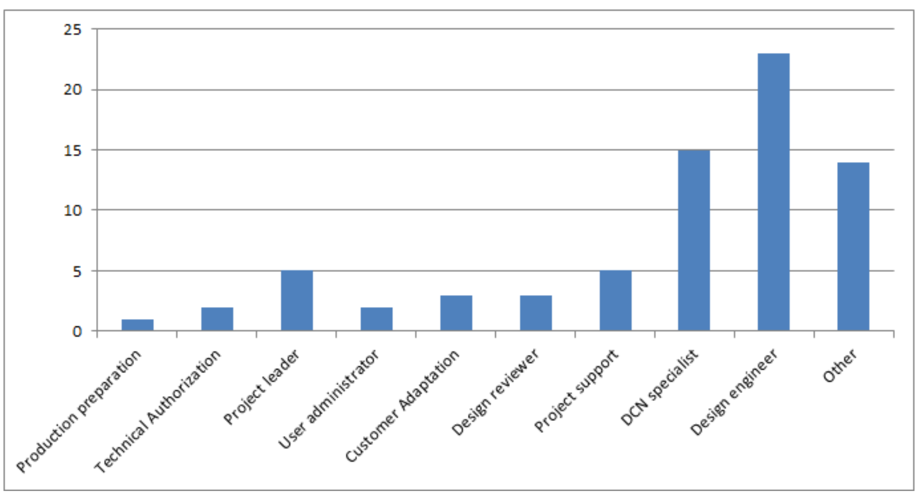

Figure 5.3: Role / responsibilities of respondents.

5.2 RQ1 - Impact of usability on process lead-time in information systems

This section answers the first research question related to impact of usability on process lead-time in information systems. The question is answered with respect to usability factors. Each factor is discussed in a separate section and is structured as Learnability in section 5.2.1, Efficiency in 5.2.2, Memorability in section 5.2.3, Errors in section 5.2.4 and Satisfaction in section 5.2.5.

5.2.1 Learnability

It can be observed from table 5.1 that learnability which is representing 29 for the number of people is one of usability factors that have a major impact on process lead-time in information systems. How easy is it for users to accomplish basic tasks the first time they encounter the design is defined as learnability by Nielsen [47].

5.2.1.1 Match between system and the real world

One of the usability heuristics that is mapped to learnability is "match between system and the real world" proves to have slight impact on process lead-time in information systems. It is stated by Nielsen [47] that the system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Also, follow real-world conventions, making information appear in a natural and logical order [47].

Visual representation

Small number of interviewees (4 out of 29) had some comments about how working with visual representation is easier and understandable for users rather than working with codes and numbers. There are a lot of parts in the system and each have their own numbers. It is hard for users to know what part they are working with by just knowing its name or number. To see the digital model users have to click on the link and it takes a while before it opens it. A design engineer suggested that:

"It would be easier and faster if one could see a small image of the digital model as a thumbnail next to the part shown in the window. "

Also, a project manager explained that visual representation provides designers with a more familiar illustration of components and a complete picture of their project while viewing or documenting their designs in the system.

"It would be good if I could see the visual view of a truck and then select the geometrical area that I am interested in and zoom-in on that area and display the relevant units, surrounding and variations."

Reports

6 of the interviewees mentioned that reports provide a better understanding of the system as they convey the necessary information of what is in progress and what has been completed to individuals involved in the process. A project leader stated that:

"Having a complete view of information related to past and future helps us to plan more effectively and avoid extra work or rework."

It was discussed during the interviews that there is a need to get complete view in forms of reports from the system to understand the big picture of the company. Users believed that the traceability of the system is really good. It gives them an opportunity to check the information from the past and also view what is going to happen in the future. Also, a customer adaptation expert shared that this type of traceability allows everyone to exactly know what each person's changes were and when this has happened.

"Finding everything about all products and knowing who has done what, when and how is very beneficial. It is especially advantageous when we would like to make use of previous versions and combinations. The reports give us the required information and make it easier for us to make maximum utilization of existing resources/material."

5.2.1.2 Consistency and standards

4 of the interviewees agreed that users should not have to wonder whether different words, situations, or actions mean the same thing and system should follow platform conventions [47].

Consistency in all windows

It was observed during 3 think aloud sessions that, existence of a flaw in the order and position of objects in the system can cause confusion. It was observed in the results of think aloud sessions that the order of Close and Help button at bottom of Search window is not convenient and the users usually clicked on Help button when they wanted to close the window. Also Search and Clear buttons were very close to each other and they clicked on Clear button instead of Search button by mistake several times. This lead to loss of all the filtering applied for search and they had to start all over again. Also, a key user described how users expect to see similar functions, features and options available in all relevant parts of the system:

"When there is a change request for a window it would be better if that request is implemented in all the similar windows and just not the window that is mentioned in the change request. When users work in similar windows they have a mindset of actions they can perform and if features available in these windows differ from each other they get confused. Each time they have to spend some time looking for what features are available and what features are missing. "

Definite words, situations or actions

In this thesis, 14 of 29 people stated that there are words, situations or actions that are not clearly expressed. One of the subjects stated that:

"It is unreasonable why I must use F3 instead of Enter in Search window. I usually press enter, then I realize that I should have had press F3 instead to have the search result."

It was repeatedly mentioned by many subjects that the terminology is not clear which causes a sense of confusion to the user. It was observed in 7 of the think aloud sessions that, many times users don't know when to use which button. For example users used delete button instead of cancel button in the variant specification window. Also, a respondent from the survey stated that unclear objects can lead to confusion and mistakes:

"Many mistakes occur from misunderstanding the difference between cancel and delete."

5.2.1.3 Help and documentation

All 29 interviewees mentioned that sufficient help and documentation provided by the system can have an impact on process lead-time. They commented about why and how help should be provided to users which is covered in more details in the following sub-sections.

PDM Logic

Understanding and learning the PDM Logic which is a combination of product logic, business logic and system logic (see section 3) is one of the main concerns of all 29 interviewees. They all find the PDM Logic very complex and they believe this is one of the main factors that are affecting their daily work. One of the project leaders explained:

"As a beginner you don't know what each field means and which fields are important to fill in. So users miss to fill in necessary fields and that is how most mistakes are made."

The logic behind documenting designs for trucks is very complex and it's hard for designers to interpret the variant specifications and come up with a valid combination. It was observed, this is where users have the most difficulties and make the most mistakes. There should be useful help documents that can guide users through these complicated processes. In addition, 29 out of 73 participants of the survey responded that the complex PDM Logic of KOLA is the main source of users' mistakes. One of the respondents explained:

"The PDM Logic is very complex. Most of mistakes are made due to lack of knowledge or education and providing help documentation is just something that has to be done".

To further validate the results from interview and think aloud methods related to complexity of PDM Logic, some questions were included in the survey. The result is illustrated in following figures which provide an overview of the complexity of PDM Logic involving different tasks: creating a DCN, creating and releasing an item, creating an Item/Variant link and selecting variant combination, checking authorizations and restrictions while creating an Item/Variant link. Figure 5.4 represents that 53% (39 respondents) believe that creating a DCN is not complex and 33% (24 respondents) think that it is slightly complex. Figure 5.5

shows that 42% (31 respondents) believe that creating and releasing an item is slightly complex and 30% (22 respondents) think that it is not complex.

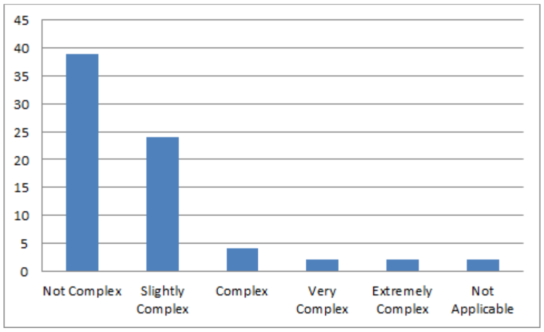

Figure 5.4: Respondents' opinion on the level of complexity of creating DCN.

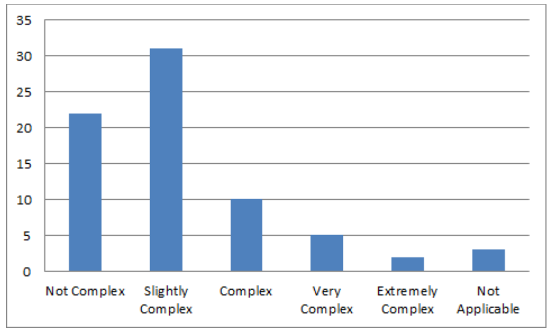

Figure 5.5: Respondents' opinion on the level of complexity of creating and releasing an item.

Figure 5.6 illustrates that 30% (22 respondents) think creating an Item/Variant link is slightly complex, 23% (17 respondents) believed is not complex and 22% (16 respondents) considered it complex.
Figure 5.7 depicts that 32% (23 respondents) believed that selecting their variant combination while creating an Item/Variant link is slightly complex. On the other hand, 23% (17 respondents) believed it is complex and 19% (14 respondents) considered it very complex.

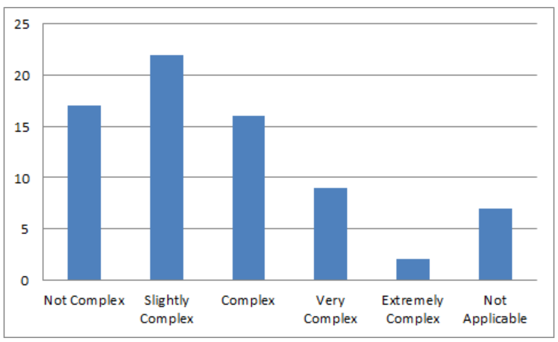

Figure 5.6: Respondents' opinion on the level of complexity of creating Item/Variant link.

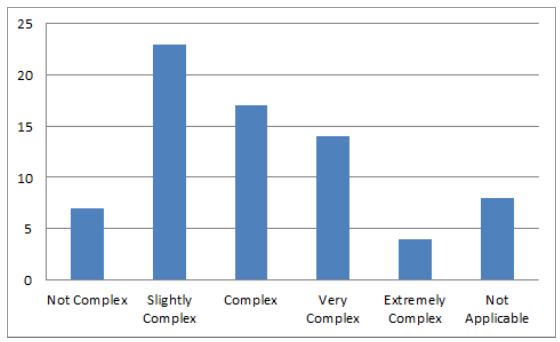

Figure 5.7: Respondents' opinion on the level of complexity of selecting a variant combination while creating an Item/Variant link.

Figure 5.8 depicts, 36% (26 respondents) believe that checking variant authorization while creating an Item/Variant link is complex and 22% (16 respondents) think it is very complex. In addition, 14% (10 respondents) considered it slightly complex but another 14% (10 respondents) considered it extremely complex.
Figure 5.9 shows that 27% (20 respondents) consider checking their variants complex and 25% (18 respondents) think it is very complex, 16% (12 respondents) consider it to be extremely complex. However, 16% (12 respondents) believe that it is slightly complex to check variant restrictions while creating an Item/Variant link.

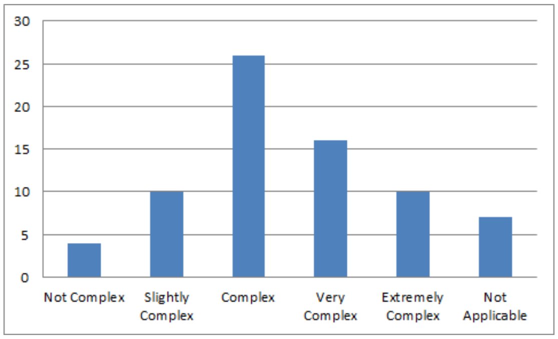

Figure 5.8: Respondents' opinion on the level of complexity of checking variant authorizations while creating an Item/Variant link.

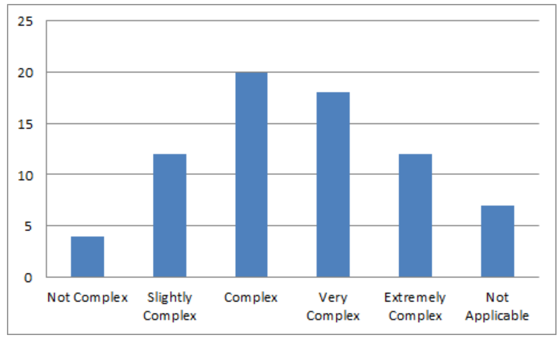

Figure 5.9: Respondents' opinion on the level of complexity of checking variant restrictions while creating an Item/Variant link.

A statistical test was conducted to further investigate and verify to what extent complexity of tasks influences the time taken to perform the tasks: creating a DCN, creating and releasing an item, creating Item/Variant link, selecting variant combinations, checking variant authorizations and variant restrictions while creating an Item/Variant link. In all of the tests, it was evident that there was a significant correlation between time taken to perform tasks and complexity which enabled the researchers to perform regression analysis on each of the combinations.

A regression analysis shown in Table 5.2 was performed between "complexity of creating a DCN" and "time taken to perform the task in KOLA" (see appendix C.19). It was observed to have a significant association as the p-value is 0.006 which is less than 0.05. On performing a regression analysis it was observed that 37.5% of the time it takes to perform the task in KOLA can be explained by its complexity. The results of regression analysis indicate that, B value is 0.44, B constant is 0.741 and regression equation is $\hat{Y} = 0.375 + 0.741(X)$.

Y	X	Sig.	Asym p. Sig.	Correlation
Respondents' opinion on the level of complexity of creating DCN.	Time taken to perform the task	Significant	0.006	R Square = 0.375 B constant = 0.741 B = 0.44 $\hat{Y} = 0.375 + 0.741(X)$

Table 5.2: Regression analysis between complexity of creating a DCN and time taken.

A regression analysis shown in Table 5.3 was performed between "complexity of creating and releasing an item" and "time taken to perform the task in KOLA" (see appendix C.22). It was observed to have a significant association as the p-value is 0.006 which is less than 0.05. On performing a regression analysis it was observed that 22.5% of the time it takes to perform the task in KOLA can be explained by its complexity. The results of regression analysis indicate that, B value is 0.359, B constant is 1.0447 and regression equation is $\hat{Y} = 1.0447 + 0.359(X)$.

Y	X	Sig.	Asymp. Sig.	Correlation
Respondents' opinion on the level of complexity of creating and releasing an item.	Time taken to perform the task	Significant	0.000	R Square = 0.225 B constant = 1.0447 B = 0.359 $\hat{Y}$ = 1.0447 + 0.359(X)

Table 5.3: Regression analysis between complexity of creating and releasing an item and time taken.

A regression analysis shown in Table 5.4 was performed between "complexity of creating Item/Variant link" and "time taken to perform the task in KOLA" (see appendix C.25). It was observed to have a significant association as the p-value is 0.000 which is less than 0.05. On performing a regression analysis it was observed that 39.3% of the time it takes to perform the task in KOLA can be explained by its complexity. The results of regression analysis indicate that, B value is 0.559, B constant is 0.944 and regression equation is $\hat{Y}$ = 0.944 + 0.559(X).

Y	X	Sig.	Asymp. Sig.	Correlation
Respondents' opinion on the level of complexity of creating Item/Variant link.	Time taken to perform the task	Significant	0.000	R Square = 0.393 B constant = 0.944 B = 0.559 $\hat{Y}$ = 0.944 + 0.559(X)

Table 5.4: Regression analysis between complexity of creating Item/Variant link and time taken.

A regression analysis shown in Table 5.5 was performed between "complexity of selecting variant combination while creating Item/Variant link" and "time taken to perform the task in KOLA" (see appendix C.28). It was observed to have a significant association as the p-value is 0.000 which is less than 0.05. On performing a regression analysis it was observed that 46.6% of the time it takes to perform the task in KOLA can be explained by its complexity. The results of regression analysis indicate that, B value is 0.678, B constant is 1.426 and regression equation is $\hat{Y}$ = 1.426 + 0.678(X).

Y	X	Sig.	Asymp. Sig.	Correlation
Respondents' opinion on the level of complexity of selecting a variant combination while creating an Item/Variant link.	Time taken to perform the task in KOLA	Significant	0.000	R Square = 0.466 B constant = 1.426 B = 0.678 $\hat{Y}$ = 1.426 + 0.678(X)

Table 5.5: Regression analysis between complexity of selecting a variant combination while creating an Item/Variant link and time taken.

A regression analysis shown in Table 5.6 was performed between “complexity of checking authorizations while creating Item/Variant link” and “time taken to perform the task in KOLA” (see appendix C.31). It was observed to have a significant association as the p-value is 0.000 which is less than 0.05. On performing a regression analysis it was observed that 49.5% of the time it takes to perform the task in KOLA can be explained by its complexity. The results of regression analysis indicate that, B value is 0.650, B constant is 1.4 and regression equation is $\hat{Y} = 1.4 + 0.650(X)$.

Y	X	Sig.	Asym p. Sig.	Correlation
Respondents’ opinion on the level of complexity of checking variant authorizations while creating an Item/Variant link.	Time taken to perform the task in KOLA	Significant	0.000	R Square = 0.495 B constant =1.4 B = 0.650 $\hat{Y} = 1.4 + 0.650\ (X)$

Table 5.6: Regression analysis between complexity of checking variant authorizations while creating an Item/Variant link and time taken.

A regression analysis shown in Table 5.7 was performed between “complexity of checking restrictions while creating Item/Variant link” and “time taken to perform the task in KOLA” (see appendix C.34). It was observed to have a significant association as the p-value is 0.000 which is less than 0.05. On performing a regression analysis it was observed that 55.7% of the time it takes to perform the task in KOLA can be explained by its complexity. The results of regression analysis indicate that, B value is 0.726, B constant is 1.144 and regression equation is $\hat{Y} = 1.144 + 0.726(X)$.

Y	X	Sig.	Asym p. Sig.	Correlation
Respondents’ opinion on the level of complexity of checking variant restrictions while creating an Item/Variant link.	Time taken to perform the task	Significant	0.000	R Square = 0.557 B constant =1.144 B =0.726 $\hat{Y} = 1.144 + 0.726(X)$

Table 5.7: Regression analysis between complexity of checking restrictions while creating an Item/Variant link and time taken.

Notification on updates

Few interviewees (3 out of 29) commented on how release notes can create awareness of new offerings among the users of the system and act as help instructions for users to learn and understand the new features. A design engineer with seven years of experience explained that these notifications are highly appreciated by all types of users:

“It would be good to have an update of what exists today and how new features work for experienced users as well. Getting information on new releases and features helps us to stay up-to-date and learn new features as the system evolves”.

Help support

Considerable number of interviewees (15 of 29) pointed out that help documents available in the system are not very efficient and thereby they usually ask for help from their colleagues. A design engineer described that:

"I never use help function in the system. Firstly, because it contains a lot of text and it is not well explained. Secondly, it is hard to search for information in the document. I always try to find a colleague and ask for help".

Another design engineer added:

"I don't use the FAQ in the system. It is outdated and it doesn't cover any of our routine issues and problems. I usually try to solve my problems by asking from my colleagues".

Insufficient help documentation cause in time loss while users spend time going around and asking for help and guidance.

To further validate the results related to help support from interview and think aloud methods, some questions were included in the survey. The results to respondents' opinions are illustrated in figure 5.10, figure 5.11, figure 5.12, figure 5.13 and figure 5.14.

Figure 5.10 represents the opinion of respondents about having a help feature like an updated FAQ list. 35% (26 responses) of the respondents believed that an updated FAQ is useful, 15% (11 responses) of them believed that an updated FAQ is slightly useful, 20% (15 responses) thought that the feature is very useful and 4% (3 responses) thought it was extremely useful. Also, there were also some respondents who considered an updated FAQ as not useful and some others had no opinion.

Figure 5.11 illustrates the respondents' opinion on having a help feature as a mouse pointer that displays additional information with the possibility of deactivating it in the window. 37% (27 respondents) considered this feature to be very useful, 29% (21 respondents) found it useful and 26 % (19 respondents) believed that the feature is extremely useful. The rest thought the feature is slightly useful or didn't have any opinion.

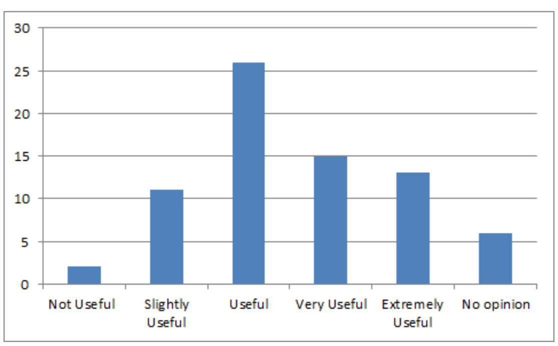

Figure 5.10: Respondents' opinion on an updated FAQ list.

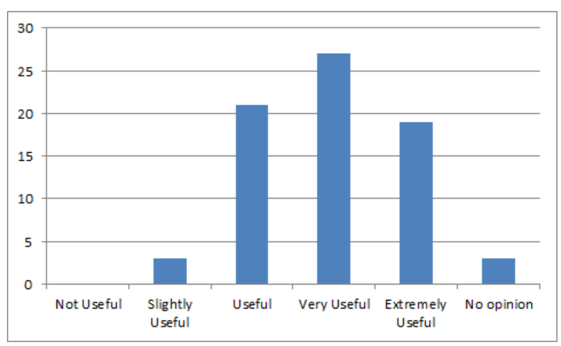

Figure 5.11: Respondents' opinion on placing mouse pointer display additional information.

Figure 5.12 depicts the opinion of respondents about a help button inside the window. 35% (26 responses), 23% (17 responses) and 12% (9 responses) considered a help button to be useful, very useful and extremely useful respectively. However, smaller numbers responded that the help button is slightly useful or not useful. In addition, 4% (3 respondents) had no opinion.

Figure 5.13 shows respondents' opinion about a help feature as a help section within the window as it exists today. It shows that 32% (23 respondents) believed that this feature is useful, 25 %(18 respondents) found it very useful and 14 %(10 respondents) considered the help section extremely useful. However, 18 %(13 respondents) believed the feature is slightly useful and the rest didn't think that the feature was useful or had no opinion.

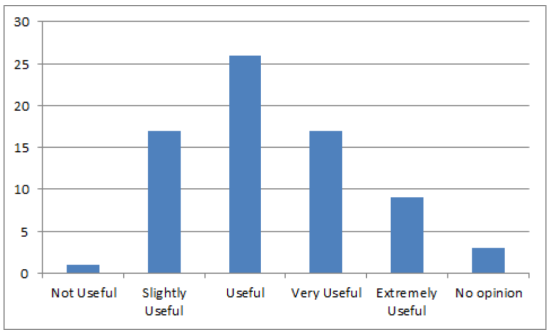

Figure 5.12: Respondents' opinion on a help button in the window.

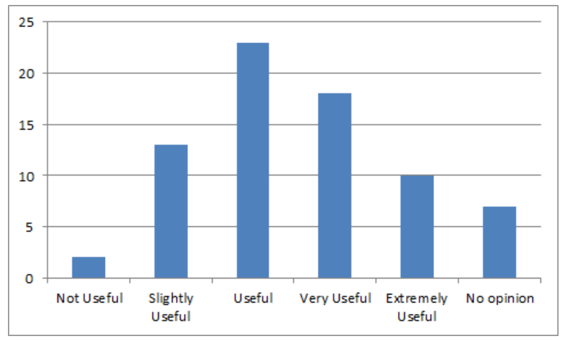

Figure 5.13: Respondents' opinion on help section within the window.

Figure 5.14 illustrates respondents' opinion on a help feature as tip of the day with the possibility of deactivating it in the window. It was observed that 27% (20 respondents) considered this feature as slightly useful and 11% (8 respondents) believed it is not useful. On the other hand, 26% (19 respondents) thought that tip of the day is useful, 16% (12 respondents) believed it is very useful and 7% (5 respondents) found it extremely useful. There were 12% (9 respondents) who had no opinion on the feature.

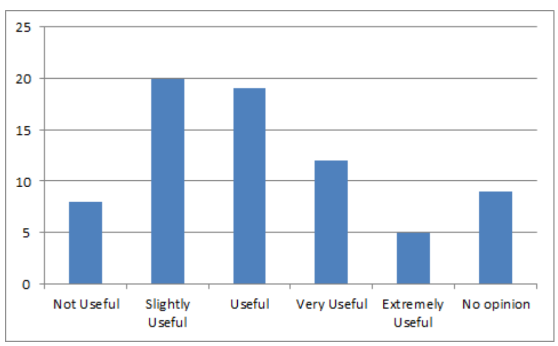

Figure 5.14: Respondents' opinion on Tip of the day.

5.2.2 Efficiency

Efficiency is a set of attributes that bear on the relationship between the level of performance of the software and the amount of resources used, with respect to time behavior, resource utilization and efficiency compliance [30]. Efficiency as of the usability factors is about how quickly users can perform tasks once they have learnt the design [47]. Out of 29 interviewees 27 of them had comments about how efficiency has an impact on process lead-time in information systems.

In addition, a question was conducted in the survey to capture users' overall opinion on the impact of ease of use and learnability of KOLA in their daily work. The result to respondents' opinion is shown in figure 5.15. It can be observed that 38% (28 respondents) believe that KOLA's usability speeds up their work. On the other hand, other 38% (28 respondents) think that KOLA's usability doesn't have any effect on their daily work.

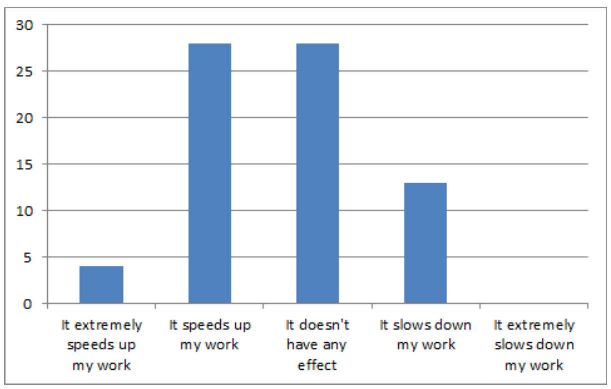

Figure 5.15: Respondents' opinion on the impact of KOLA's usability on their daily work.

5.2.2.1 Visibility of system status

Number of interviewees (11 out of 29) mentioned that the system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

Notification messages - Visibility

Notifications are the primary source from which one receives information about the activities that were performed on the system. During three of the think aloud sessions, researchers observed that notifications in the system are not spotted by the subjects. As one of the participants was performing a task he complained about not getting confirmation messages from the system whereas in the system there was a notification displayed but he wasn't able to spot it:

"Whenever I input information and press save, I am not sure if my data has been saved successfully or not."

Comprehend notification messages

One of the subjects explained that, it was important for him to completely understand what the notification messages actually meant. He explained:

"Notification should be a concise and informative, so it can really help me in my activities in the system ".

Notification on system status

9 interviewees mentioned that they appreciate receiving a notification on the current status of the system and be aware of the processes that are happening within the system. One of the interviewees said that:

"Users feel that they have control when the notifications are displayed. Without any notifications, users feel like they are lost and not sure if what they are doing is correct or not. So they have to spend some time on trying to figure out the situation."

Also, a design engineer explained how notifications in the system can help to work more efficient:

"When I use WhereUsed function in the system and rows are highlighted in the variant specification matrix there is no notification indicating how many rows are highlighted. The matrix can be very long and you wouldn't know how many rows are highlighted until you scroll down and count."

5.2.2.2 Flexibility and efficiency of use

Noticeable number of Interviewees (27 of 29) had comments about how flexibility and efficiency of use has an impact on the process lead-time.

In addition, an attempt was made to further study the efficiency of the system by including number of questions about the time it takes for participants to accomplish specific tasks: creating a DCN, creating and releasing an item, creating an Item/Variant link and selecting variant combination, checking authorizations and restrictions while creating an Item/Variant link. The results to this attempt are discussed in the following paragraphs.

It can be observed from Figure 5.16 that 44% (32 respondents) take less than 5 minutes, 16% (12 respondents) take 5 to 10 minutes and 22% (16 respondents) take 10 to 15 minutes to create a DCN.

Figure 5.17 depicts that 33% (24 respondents) take 10 to 15 minutes and 21% (15 respondents) to create and release an item. Also, it can be observed that 15% (11 respondents) believe it takes 5 to 10 minutes and another 15% (11 respondents) believe it takes more than 20 minutes.

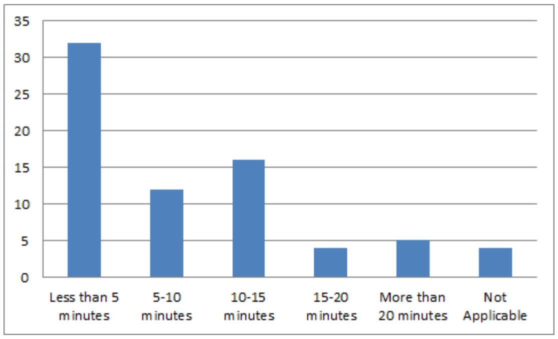

Figure 5.16: Respondents' opinion on the amount of time it takes to create DCN.

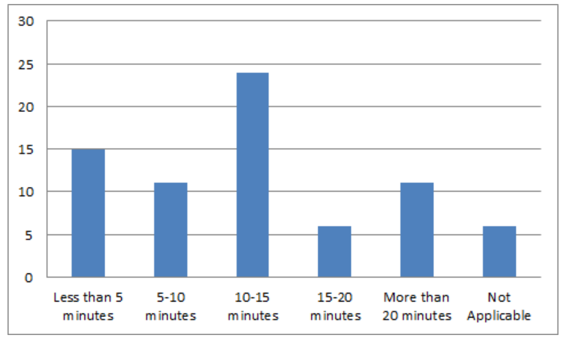

Figure 5.17: Respondents' opinion on the amount of time it takes to create and release an item.

Figure 5.18 shows that for 33% (24 respondents) it takes less than 5 minutes and for 27% (20 respondents) it takes 10-15 minutes to create an Item/variant link.

Figure 5.19 represents that 26% (19 respondents) take 5 to 10 minutes, 23% (17 respondents) take less than 5 minutes and 21% (15 respondents) take 10 to 15 minutes to select their variant combination while creating an Item/Variant link.

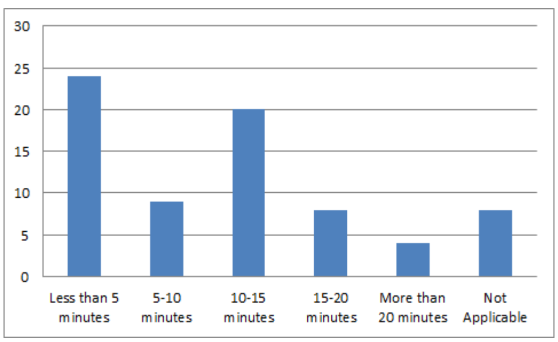

Figure 5.18: Respondents' opinion on the amount of time it takes to create Item/Variant link.

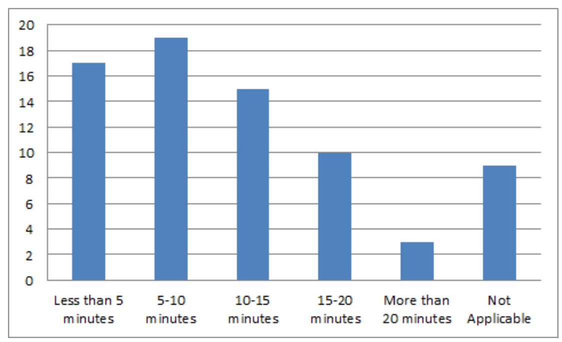

Figure 5.19: Respondents' opinion on the amount of time taken in selecting a variant combination while creating an Item/Variant link.

It can be observed from figure 5.20 that 23% (17 respondents) take 10 to 15 minutes, 19% (14 respondents) take 5 to 10 minutes, 18% (13 respondents) take less than 5 minutes and 16% (12 respondents) take 15 to 20 minutes to check their variant authorization while creating an Item/Variant link.

Figure 5.21 illustrates that 23% (17 respondents) take 10 to 15 minutes, 22% (16 respondents) take 15 to 20 minutes and 19% (14 respondents) take 5 to 10 minutes to check their variant restriction while creating an Item/Variant link.

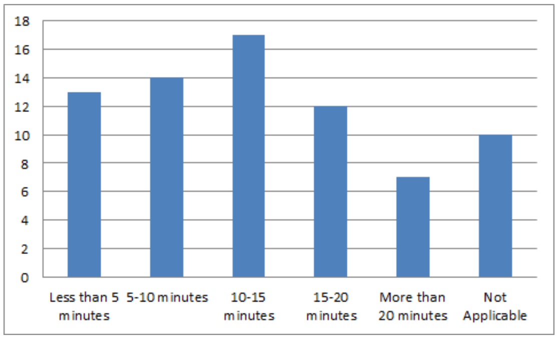

Figure 5.20: Respondents' opinion on the amount of time it takes to check variant authorizations while creating an Item/Variant link.

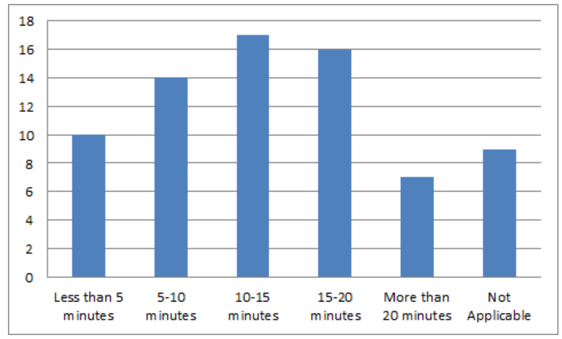

Figure 5.21: Respondents' opinion on the amount of time it takes to check variant restrictions while creating an Item/Variant link.

Multiple Windows

Many interviewees (12 of 29) mention that how data is accessed and viewed plays an important role and affects the efficiency of their work. Number of design engineers mentioned that they like to have the possibility to view different data in distinct windows. A project leader emphasized:

"I really like how I can open several windows and view information in different windows. This makes it much easier for me to compare data by just placing two windows next to each other. This saves a lot of time for me since I wouldn't need to go back and forth or switch between two windows to compare and get the whole picture. "

Also, there were some comments about how confusing it is to have each window open as a distinct window and a list of all these open windows in the taskbar. It was observed during 7 think aloud sessions that when users have many windows opened it gets hard for them to find the specific window among all the opened windows. Consequently, users spent some time opening different windows until they open the specific window they were looking for. Also, a designer explained:

"While I am working in the system, I might open 10 different windows and need to switch between the windows several times. It is very annoying when each time I have to look for a while to find the window I want to work with, in between all the others."

Search

More than half of interviewees (18 of 29) find search function very useful especially when they have to deal with a lot of data. They appreciate how they can tailor their search by adding and removing attributes to filter out data. In addition, they believe search aids them to work more efficiently and speeds up their process in finding information in the system. A project manager explained:

"Search functions in the system are really flexible. You have a lot of filtering options and you can adjust the filtering attribute in a way that it meets your searching requirements. This provides an easy and fast access to information."

During a think aloud session, a participant complained about how absence of search function in some part of the system slows her down and she has to make extra effort and spend more time to find the information she needs. she pointed out an example by saying:
"I would like to have a search option in this window. The list is very long and it takes a lot of time for me to look through the whole list and find the restrictions that I am interested in."

Multiple Operations

Some interviewees (6 out of 29) stated that performing multiple operations plays an important role in accelerating their daily work. They mentioned how this features can be useful when they have to carry out noticeable number of similar modifications at once and save a lot of time. A technical authorizer mentioned that some users have to input or update a lot of data and they need accelerators to increase the pace of their work:
"We have difficulties when we want to change a lot of things. For example, when we want to do multiple updates to parts, there is no feature available to add several parts to a DCN. Sometimes users have a list of 200 part numbers and they should be able to input the whole list at once. Adding them one by one is going to take a lot of time from them."

Built or change Functions / Features

During the process of collecting data and drawing conclusions, researchers found how lack of some functions and features and insufficiencies in others have an impact on process lead-time. Out of 29 of interviewees 11 of them had change requests for making the system more efficient and flexible. A design engineer requested for a new functionality while explaining how adding this functionality can facilitate their work process.
"Another area that needs to be improved in KOLA system is having an efficient subscription feature. One main request is that I want to be able to select my function group along with certain variants and receive updates related to only these selections."

Extra steps to perform a task

About one fourth of the interviewees believed that considerable amount of time are wasted on performing extra steps to accomplish a task. A design engineer described this situation by providing an example:
"You need to do extra clicks in the system to get to the information you want. For example, you have to navigate through several windows before you can reach the window that holds the data you are interested in."

Right click shortcuts

Considerable number of the interviewees (22 out of 29) agreed that accelerators such as shortcuts increase velocity of their performance. These shortcut features are created with the aim of facilitating user's work in the system. A design engineer pointed out:
"There are quite number of really good shortcuts in the system which really eases and speeds up our work. For Example, we can use right click shortcut to directly navigate to another window instead of going through the main menu and navigating to that specific window."

In addition, a DCN specialist emphasized on the importance of shortcuts and their benefits by saying:
"I mainly use shortcuts to do my work. These shortcuts save me from performing extra steps and they direct me directly to the content I want. I would like to have more and more of these types of shortcuts implemented into the system."

5.2.2.3 User control and freedom

Small number of interviewees (3 of 29) talked about the impact of user control and freedom on their daily work. They mentioned that it is important that users be able to exit anytime of their choice or return to an earlier state, in case of choosing system functions by mistake.

Support undo and redo from mistake
According to a design engineer, most of the users have a complex role to perform in the company, therefore they need a redo and undo option. Also, another interviewee explained how just a click of undo would reduce a great deal of rework:
"I have to start over if something goes wrong, if only I could Ctrl+Z my action I would probably end up saving 2 hours of my work".

5.2.3 Memorability

Memorability is about the quality of something, being able to easily remember or worth remembering [47]. Results in table 5.1 depict that all 29 participants believed that memorability has an impact on process lead-time.

5.2.3.1 Recognition rather than recall

Nielsen [47] states, recognition rather than recall is a usability heuristics that is about minimizing the user's memory load by making objects, actions, and options visible. He further explains that the user should not have to remember information from one part of the dialogue to another and instructions for use of the system should be visible or easily retrievable whenever appropriate. All 29 interviewees had comments about the impact that this usability heuristic has on their daily work process which is discussed in the following sub-sections.

Visibility of objects, actions, and options
All the interviewees constantly mentioned that users have difficulties in finding the options they need which led them to spend some time for finding them. One of them stated that:
"There are a lot of useful features in the system but it's always hard to find them in the system and you wouldn't know where to look for them. We spend so much time finding these features and it gets frustrating".
A key user explained by saying;

"A lot of features are available but they are not all visible in the window and users need to reach them from the menu bar or by right clicking. Therefore, it gets hard for users to find the features they want."

Instruction of use

The purpose of instruction of use is to provide the user a guide to understand and utilize the system to the best possible extent. Many of the subjects in the interview mentioned that, if there is a small sign next to labels, buttons and text fields explaining the purpose of its existence would enable the users to make fewer mistakes. Also, they agreed that these instructions would enable them to work independently without much support.
To further investigate this, a question about KOLA being self-explanatory was included to the survey and the result to respondents' opinion is illustrated in figure 5.22. It shows that 34% (25 respondents) disagreed and 30% (22 respondents) strongly disagreed that KOLA is self-explanatory. However, 15 % (11 respondents) agreed that KOLA is self-explanatory and 19% (14 respondents) neither agreed nor disagreed.

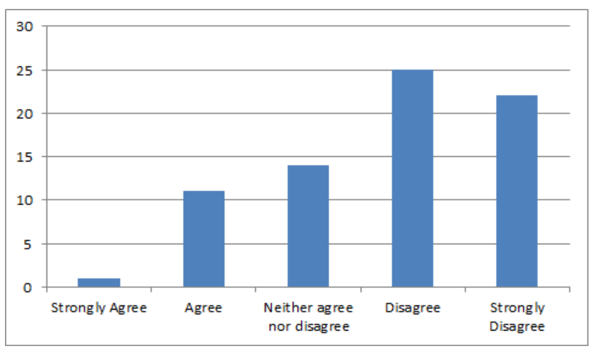

Figure 5.22: Respondents' opinion on KOLA being self-explanatory.

5.2.4 Errors

An 'error' is a deviation from accuracy or correctness. 25 participants expressed that errors can occur because of lack of knowledge, misinformation, or simple keying mistakes and there could be several reasons for the causation of errors and system could provide notification on its occurrence [29]. Errors can be prevented in several ways. The opinions on system support to reduce errors and in turn the process lead-time is presented in this section.
Figure 5.23 illustrates respondents' satisfaction about KOLA's feedback information, as errors and notification. It can be observed that 44% (32 respondents) agreed and 24% (18 respondents) neither agreed nor disagreed. On the other hand, 32% (22 respondents) disagreed that the feedback information in KOLA is satisfactory. In addition, a regression analysis was performed between "respondents' opinion about the feedback information (Errors and Notification) in KOLA" and "years of experience".

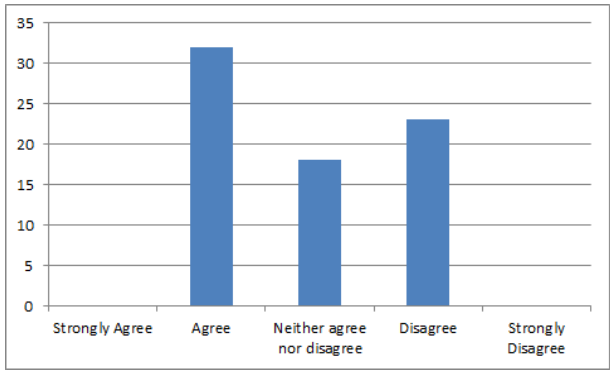

Figure 5.23: Respondents' satisfaction about feedback information in KOLA.

5.2.4.1 Error prevention

Without error prevention, every change usually introduces a large number of errors that are costly to find and fix [38]. This was confirmed by 12 interviewees out of 29 participants. The following explanation describes the impact of error prevention on process lead-time.

Comprehend Warning messages

Warning is one of the ways to prevent errors. A warning message in the system notifies the user that there is an error but would still allow the user to go ahead and make the choice. It was observed during one of the think aloud sessions that the warning is just overlooked and they bypass it without even reading it. The users grab the first possible opportunity to get them out of sight and ignore the warning message window or pop-up. Four participants did not believe that, the warnings were relevant to them and they chose to ignore them.

System design for error prevention

System could be designed in a way such that users do not make a mistake. Number of interviewees (13 out of 29) believed that system design can prevent users from making mistakes and work more efficiently. A key user stated that:

"To prevent errors, it is necessary to build the system in such a way that the user would not make mistakes. The interface must be carefully designed that it does not allow the user to commit a mistake at all or leave as little possibility to make mistakes as possible. The system must be so intuitive that it inherently prevents users from making mistakes."

Also, a project leader stated that:

"The system must somehow guide users and help them to perform the tasks correctly. For example, have a main/general window showing the first tab and then getting to next tabs by clicking the next button to proceed with the process".

This statement was reconfirmed in survey. Figure 5.24 shows the usefulness of support provided by step by step guidance while creating Item/Variant link. 33% (24 of 73) of the respondents believe that this feature is useful, 30% (22 of 73) of them believe that it's very useful while 23 %(17 of 73) of them believe that it's extremely useful. Only 13 %(10 of 73) of the respondents thought that the feature was slightly useful.

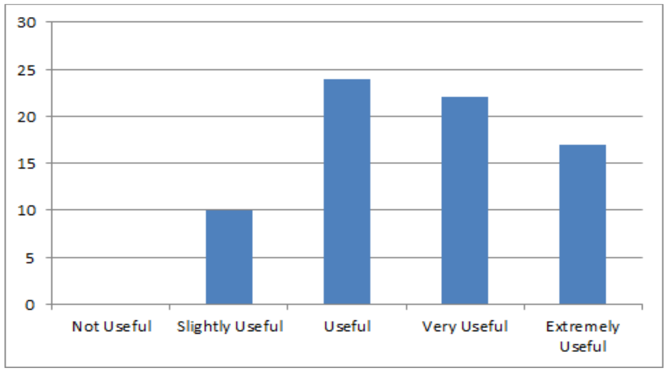

Figure 5.24: Respondents' opinion on having system support for step By step guidance while creating Item/Variant link.

5.2.4.2 Help users recognize, diagnose, and recover from errors

An error is a notification to the user that an unexpected condition has occurred during the process. Error messages should be expressed in plain language, precisely indicates the problem, and constructively suggests a solution. About half of the interviewees (14 out of 29) complained about how the error messages are incomprehensible and incomplete. The following discussions describe these comments in detail.

Comprehend Error messages

One of the interviewees mentioned that the error messages must be clearly understandable to educate users along the way and reduce the work required to fix the problems and errors. One of the project leader said that most users feel that:

"Error messages are not always clear and they have to ask for someone's help to understand the meaning of them".

System Controls and checks

It was mentioned by number of interviewees (13 of 29) that the system must somehow control the activity of a user or alternately prevent the user from performing the action. One of the design engineers mentioned that:

"When encountering an error, I expect the system to provide an error message preventing further action or a severe warning message to ensure that I am aware of what I was trying to do. I feel confident that I am not making a mistake if the system can check this for me".

Also, a key user explained by saying:

"These checks and controls enforce the user to always perform the right actions leading to fewer errors. Fewer errors can be interpreted as working more efficient, avoiding redo and saving a lot of time."

In addition, few number of respondents (6 out of 73) from the survey also talked about how system control can help the users to perform more efficient and make less mistakes. A respondent stated:
"In the I/V structure there is a lot of oversteering with too many variants which I believe depends on a lack of proper system control and possibilities to get feedback from the system."

5.2.5 Satisfaction

In one of the think aloud sessions it was observed that, a system must have a simple and pleasant design which is easy to use and learn which augments to satisfaction. Also, it was expressed by 13 participants that the satisfaction had an impact on process lead-time. The following section presents the users' perceptions and expectations.

5.2.5.1 Aesthetic and minimalist design

13 of 29 participants believed that the success of a system with respect to usability greatly depends on how simple and easy it is to use, and dialogues should not contain information which is irrelevant or rarely needed. The following sections present the participants opinion on information available and their relative visibility.

Direct link or integration to other systems
8 participants expressed their preference of having a direct link or integration with other systems. They complained that it consumed a lot of time and energy to update the data into each of these systems. A key user expressed that:
"It would be good if all these systems were integrated and the data would be automatically updated with just one click. And, we don't have to update each of the systems separately".
It was observed that many related systems were used along with this system. There was also a need to keep some parts of the data consistent among all of the systems to gain full coverage of the process. A key user defended the situation as:
"I know many people prefer integration but it is not possible to have all the functionality to be built into one system and still have that system that is fast, efficient and easy to use".

Handling Fields, buttons, tabs and matrix table in window / User interface
It was observed in the think aloud sessions that, it is very important to have a clean and non-distracting user interface. The researchers noticed that the design and colors were not attractive to the eyes of users and the interface did not deliver all the information that it intended to deliver. Screen was filled with a lot of details and it was not easy for users to learn and use.
There were several interviewees (11 of 29) who commented on how it would be good to customize the system. Also, they mentioned how too much information displayed at once leads them to make mistakes. One of the design engineers stated that:

"I don't like when there are many columns in the matrix because, it gets very complex and it is possible to miss something and make mistakes."

Finally, some suggestions for improvements were included in the survey to reduce the process lead-time in information systems. Figure 5.25 depicts the different opinions expressed by the respondents on what to change, in order to improve KOLA's ease of use and learnability. 28 respondents thought that improving the user interface would help in ease of use and learnability. Also, 32 respondents believed in making KOLA more intuitive, 43 respondents believed in increasing training and e-learning material and 24 respondents believed in improving help and support. Further, 21 respondents believed that modifying logic behind KOLA and 26 respondents believed that integration with other systems would be beneficial.

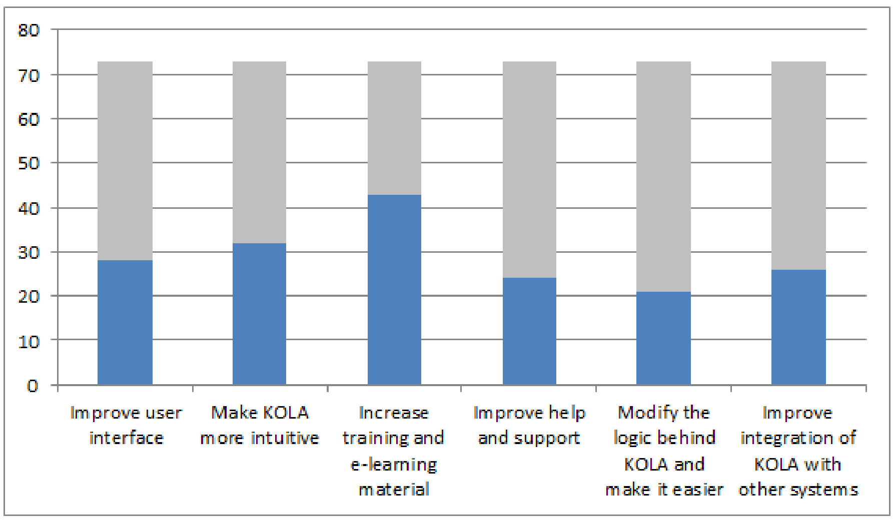

Figure 5.25: Respondents' opinion on improving KOLA the ease of use and learnability in KOLA.

5.3 RQ2 - To what extent does the experience level of the users, impact usability in information systems?

From section 5.2, it is evident that there is an impact of usability on process lead-time in information systems. Further, it would be interesting to know how the experience level of users, impact the usability of information systems. Section 5.3.1, 5.3.2, 5.3.3, 5.3.4 and 5.3.5

explains the impact of usability with respect to experience level of users having Learnability, Efficiency, Memorability, Errors and Satisfaction as high focus respectively.

5.3.1 Learnability

In section 5.2.1, there were interesting findings on how learnability has an impact on process lead-time. In this section, we can observe how learnability is influenced by users with different levels of experience.

5.3.1.1 Consistency and standards

Importance of consistency and standards in a system varies according to level of user's experience. Thus, this section shall discuss the views of users with different levels of experience.

Consistency in all windows

As mentioned before in section 5.2.1.1, following platform conventions is needed to reduce mistakes. During a think aloud session it was observed that when a user who had experience with one part of the system had less difficulty to learn and use another part of a system that he had no experience in before. One design engineer with 2.5 years of experience in creating items in Item window could easily manage to create a new DCN in a DCN window. He stated that:

"I could easily figure out how to create a new DCN as I already know how to create a new part. It seems rather similar".

However, new users had relatively higher difficulties to manage to use a new part of the system which they had never encountered before.

Definite words, situations or actions

As discussed earlier, consistency in words situations or actions is necessary. It was observed in 8 think aloud sessions that users pace of operation is affected when there are ambiguous terminology, regarding their experience level. During a think aloud session, a new user said that:

"I thought the File->New meant new window altogether. I did not expect it to add a new item in the same window. It should have said 'Add' and not 'New'. Also the New option in menu is messy and confusing".

And another user with 1.5 years of experience with the system stated that:

"It was hard for me to figure out what different options meant or what their functionalities were when I started working with KOLA."

On the other hand, during think aloud session we noticed that experienced users didn't have doubts about the meaning of different terminology used in the system.

PDM Logic

From Table 5.1, it is evident that there is a high number of people having issues with PDM Logic. Further, it was interesting to know if the experience of users has an impact on PDM Logic. Thus, Figure 5.26 depicts the results of this study. 7 respondents with 0 to 4 hours, 9 respondents with 4 to 20 hours and 15 respondents with over 20 hours of working in KOLA every week reflected that PDM Logic is hard to understand. 4 respondents with 0 to 4 working hours per week, 1 respondent with 4 to 20 working hours per week and 2 respondents with over 20 working hours per week reflected that user interface is hard to understand. 4 respondents with 0 to 4 hours, 4 respondents with 4 to 20 and 4 respondents over 20 working hours per week suggested that both PDM Logic and user interface is hard to understand. While the rest believed that no areas were hard to understand.

Figure 5.27 illustrates that 20 respondents with over 8 years and 10 respondent with than 8 years of experience with KOLA believed PDM Logic is the hardest to understand. Also, 3 respondents with more than 8 years and 5 respondents with less than 8 years of experience thought user interface is the hardest to understand. Both PDM Logic and user interface was considered hard to understand by 7 respondents with less than 8 years and 5 respondents with more than 8 years of experience. On the other hand, 6 respondents with less than 8 years and 17 respondents with more than 8 years of experience believed neither PDM Logic nor user interface is hard to understand.

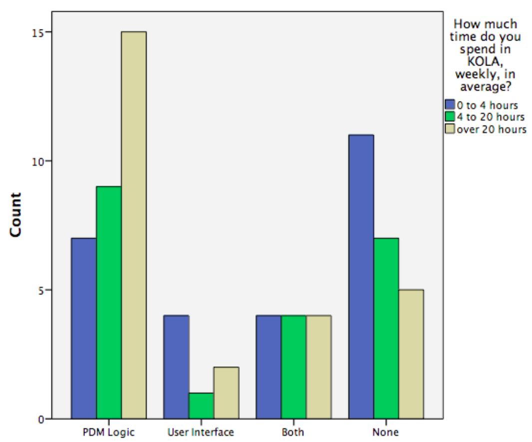

Figure 5.26: Respondents' opinion on how hard it is to understand the PDM Logic and user interface with respect to number of hours they spend on KOLA every week.

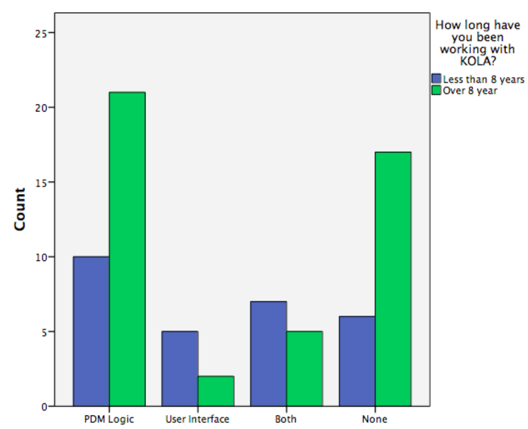

Figure 5.27: Respondents' opinion on how hard it is to understand the PDM Logic and user interface with respect to the number of years they have worked in KOLA.

Further a statistical test was conducted to see if there was a significant relation between the average time spent by users in KOLA per week and complexity of tasks: creating a DCN, creating and releasing an item, creating Item/Variant link, selecting a variant combination, checking variant authorizations and variant restrictions. The same tasks were also tested for significance with the number of years the users have used KOLA. In both tests, it was evident that there was no significant correlation between complexity and experience (see appendix C.17 to C.34).

5.3.2 Efficiency

It has been observed from Table 5.1 that efficiency has a high impact as 27 people state that there are some issues related to efficiency. Further, the following section describes how the different experience levels of the people affect impact of efficiency.

5.3.2.1 Visibility of system status

Visibility of system is observed to have some implications on usability and process lead-time. This can be seen from Table 5.1 and explained in the following sub-sections.

Notification messages - Visibility
From the results of the interview it was observed that, notification messages play an important role for both experienced and new users. But the physical location of the notification plays an important role for the benefits of it. The experienced users usually located it in the system and benefitted from the notifications. However, the new users missed it as the color, font and location was easy to miss. This makes it harder for the new users to understand the status of the system. One new user complained:
"I am always actively looking for a message bar where I can check if my worked was saved or not. But I almost never find it. But when I have located it once, next time I know where to look for it".
Another user with 3.5 years of experience reconfirmed this finding by stating:
"I have recently found the notification bar. All notifications are at the bottom of the window and it is not very noticeable for users".

5.3.2.2 Flexibility and efficiency of use

It has been observed from Table 5.1 that flexibility and efficiency of use has a high impact as 27 people state that there are some issues related to flexibility and efficiency of use. Further, to validate this result from interview and think aloud methods; a statistical test was conducted to see if there was a significant relation between the average time spent by users in KOLA per week and time taken to perform tasks: creating a DCN, creating and releasing an item, creating Item/Variant link, selecting a variant combination, checking variant authorizations and variant restrictions. The same tasks were also tested for significance with the number of years the users have used KOLA. In both tests, it was evident that there was no significant correlation between time taken to perform tasks and experience (see appendix C.5 to C.16).

Multiple Windows

The results show that experienced users distinguished between different windows without much difficulty due to their experience of handling these windows; however, new users get confused easily while working with multiple windows. A DCN specialist who had five years of experienced explained how she handles working with multiple windows:

"After years of experience working with KOLA, I have learnt the code numbers shown next to the name of each window. By looking at the list of opened windows in the taskbar, I can easily select the window that I want by reading the code number."

On the other hand, a new user with six month of experience described how hard it is for him to select the window he is interested in by looking over the list of opened window in the taskbar:

"It is not easy for me to work with having multiple windows opened in the system. I wish there was a specific icon for each window so that I wouldn't need to open each window in the list one by one to find the window I am looking for. This way I can find the window by just looking at the list of opened windows and recognizing the icon."

The way, in which the windows are accessed in a system, affect user's work pace. One key user suggested adding a feature to the system so that users can tailor window's access according to their needs:

"There should be an option for users to choose between opening a window as a new tab or as a new window so that they can benefit from both having multiple windows opened individually and having multiple windows grouped as tabs in a single window."

Search

As already discussed in section 5.2.2.2, users find search as an effective function in their daily work, since they can find information easily while tailoring their search attributes and filtering out data. However, number of interviewees (8 of 29) commented on how new users are less aware of search in different part of the system which leads them to spending more time finding information. A project manager explains the situation by saying:

"The search functionality in the system is very useful for us. Every part of the system holds a lot of data but we are interested only in specific information each time and search function helps us to filter and select only the information we want. Unfortunately, not all users and especially new users are aware of different search functions that are available in different parts of the system and this makes it harder for them to find information and work efficiently."

The experienced users are aware of these unseen searches in different parts of the system due to the years of experience and benefit from them to work more efficiently.

Multiple Operation

Researchers observed that experienced users are aware of multiple operations in different part of the system and benefit from these accelerators to increase their work pace. On the other hand, these multiple operation remains unnoticed to new users. During 5 think aloud sessions researchers observed that less experienced users are not aware of all the multiple operations that they can actually benefit from to work faster and more efficiently. For instance, a design engineer complained about lack of a multi selection option which already existed in the system:

"In item-to-variant window when a designer wants to create a new link they have to copy the variants names from one window and paste it in the other window one by one, but it would have been much easier and faster if they could have a multiselect option."

Extra steps to perform a task

During 6 think aloud sessions, researchers observed that for some tasks new users took extra steps to perform which could have been accomplished in fewer steps. Experienced users have learnt the fastest and most efficient approach to carry out a task, due to years of experience; therefore, they avoid performing extra steps. A key user explains the situation:

"There is a simple way to remove parts from a released DCN. Users who are less experienced usually select each part one by one and they remove the DCN from it. What they don't know is that they can simply open the DCN and delete all the parts from the DCN itself. "

Right click shortcuts

Shortcuts proved to have an impact on shortening the process lead-time, as explained in section 5.2.2.2; however, there is a probability that users stay unaware of their existence in the system and miss out on their benefits. These shortcuts don't have a fixed location in the interface and they can be accessed via keyboard keys or right clicks. After working with the system for a while, experienced users have figured out these shortcuts in the system; however it was observed that new users are ignorant to these shortcuts. A key user declares:

"I really like the shortcuts available in different parts of the system, they are very efficient; however, not everyone are aware of them which means they have to spend more time to do a task without help of shortcuts. "

In five think aloud sessions the researchers observed how the subjects did not use shortcuts, due to lack of awareness and performed extra steps to accomplish their tasks.

Also, four interviewees mentioned that it is hard to spot where you can use right click shortcut as there is no sign to indicate where in the system this feature is available. A design engineer, new to the system with 6 month experience, complained saying:

"There are some fields in the window that you can right click on them to get a list of shortcuts, but it is hard for me to tell on which fields I can right click and on which fields I can't. It would have been much easier to distinguish between them if there were a sign or a change of color for these specific fields. "

5.3.3 Memorability

It has been observed from results from the interview and think aloud sessions that memorability has a high impact as 29 people state that there are some issues related to memorability. Further, the following sub-sections describe how the different experience levels of the people affect impact of memorability.

5.3.3.1 Recognition rather than recall

Recognizing certain objects, options or functions is observed to have some implications on usability and process lead-time in Table 5.1. It extent of implication could vary between experienced and new users and they are discussed in the following sections.

Visibility of objects, actions, and options

It was observed repeatedly during the think-aloud sessions that the new users had troubles to quickly find the objects and options. They could not relate easily and identify where to look for the features they needed. They believed that it was needed to clean-up the interface so it would be more obvious to find the features and functions they were looking for. On the other hand, the experienced users liked it the way it was. One senior design engineer stated that:

"Even with his eyes closed or in his sleep he could check the full family of a variant in Vspecs window. I do not have to think or look for the feature".

The experienced users know all the objects, action and options and have learnt it due to experience; whereas, the new users have to fish for the functions each time.

Instruction of use

As discussed in 5.2.3.1, we understand that the new users support the idea of getting extra instructions and clarification on the buttons, labels and fields. 9 participants believed that instructions of use predominantly reduced the effort on understanding the system terminology and performing the tasks. In contrary, the experienced users did not support the idea of having system support or instructions of use like mouse pointer messages to help the user perform better. Further, when a test for independence between two variables which are respondents' opinion on KOLA being self-explanatory and average time spent in KOLA per week was performed, it was observed that there was no significant association between the two as the p-value was greater than 0.05 (see appendix C.1). Also, in another test it was also observed that there was no significant association between KOLA being self-explanatory and the number of years respondents have worked with KOLA (see appendix C.2). In this regard, a senior design engineer expressed his opinion as:

"It will be extremely annoying if there is a pop-up sign everywhere. It might be useful to relatively new users when they hold the mouse over; a small popup description appears to understand what the field does. I would not mind having this feature as long as it can be a turned on and turn off whenever I wish. In general, I am not such a big fan of this but I don't mind".

5.3.4 Errors

It has been observed from Table 5.1 that errors has some impact as 25 people state that there are some issues related to errors. To validate this result from interview and think aloud methods; a statistical test was conducted to see if there was a significant relation between the average time spent by users in KOLA per week and the satisfaction of users about the feedback information delivered by KOLA. It was evident that there was no significant correlation between these two variables (see appendix C.3). However, when the same test was repeated to check the association between "satisfaction about feedback information in KOLA" and "years of experience the users have in KOLA", it was observed to have a significant association as the p-value is 0.015 which is less than 0.05 (see appendix C.4). On performing a regression analysis it was observed that 8.6% of the satisfaction about feedback information in KOLA can be explained by the number of years the user has been using KOLA. The results of regression analysis indicate that, B value is 0.548, B constant is 2.238 and regression equation is $\hat{Y} = 2.238 + 0.548(X)$.

Y	X	Sig.	Asymp. Sig.	Correlation
Respondents' opinion about the feedback information in KOLA	Years of experience	Significant	0.015	R Square = 0.086 B constant =2.238 B =0.548 $\hat{Y} = 2.238 + 0.548(X)$.

Table 5.7: Regression analysis between respondent's opinion about the feedback information in KOLA and the years of experience.

5.3.4.1 Error prevention

Table 5.1 suggests that preventing errors could shorten the process lead-time. The following section describes how the different experience levels can contribute to shorten process lead-time.

System design for error prevention

Having a system design where the system guides the user to perform their tasks could be a very innovative idea. One of the very new design engineers mentioned that:

"A step by step guide would prevent me to ask colleagues about how to perform the tasks all the time. It helps me to perform better on the project as I don't have to focus on the methodology of the process but just follow the system".

An experienced user who works with the system for about 7-8 hours a day stated that:

"A system design cannot fully support error prevention. The user must know exactly what is supposed to be done. Eventually in times of crisis a design engineer must be able to fix it. An engineer would lose his value and purpose if he doesn't completely understand and the system does it for him".

To validate this result from interview and think aloud methods; a statistical test was conducted to see if there was a significant relation between the "average time spent by users in KOLA per week" and "the opinion of users about step by step guidance while creating an Item/Variant link in KOLA". It was evident that there was no significant correlation between time taken to perform tasks and opinion on having a step by step guidance (see appendix C.35).

When the same test was repeated to check the association between "opinion on step by step guidance while creating an Item/Variant link in KOLA" and "years of experience the users have in KOLA", it was observed to have a significant association as the p-value is 0.028 which is less than 0.05 (see appendix C.36). On performing a regression analysis it was observed that 6.4% of the opinions on step by step guidance while creating an Item/Variant link in KOLA can be explained by the number of years the user has been using KOLA. The results of regression analysis indicate that, B value is 0.387, B constant is 1.47 and regression equation is $\grave{Y} = 1.47 + 0.387(X)$.

5.3.4.2 Help users recognize, diagnose, and recover from errors

It has been observed from results that help users recognize, diagnose, and recover from errors has an impact as 14 people state that there are some issues related to it. Further, the following sub-sections describe how the different experience levels of the people affect the impact of this heuristic factor.

Comprehend Error messages

As discussed in 5.2.4.2, the new users are usually confused about the error messages. It is hard for them to understand exactly what the error means and how it can be rectified. When we asked an experienced user who has been using the system for past 8 years he answered:
"The error messages don't bother me. I don't need to consciously think about what errors appear and what they mean. I think I know, what they mean. Surely I know how to fix them. Alternatively, I know where to look for the error to identify the root cause for it".

System Controls and checks

The new users feel the necessity to have the system perform the controls and checks. 3 design engineers mentioned that a system check makes them feel confident about their work and they do not have to waste time going back and forth to verify their work before they hit submit. In several other cases, if the system prevents them from making any mistakes at all, they would never have to rework due to mistakes of earlier phases.
On the other hand, a user with 6 years of experience said that:
"I don't need any system control or check; I know what I am doing. A system control or check would only add additional pop-ups and waste my time. I don't want to be clicking on pop-ups all the time."

5.3.5 Satisfaction

It has been observed from Table 5.1 that satisfaction has a small impact in this case study as 13 people state that there are some issues related to satisfaction. Further, the following section describes how the different experience levels of the people affect impact of satisfaction.

5.3.5.1 Aesthetic and minimalist design

Table 5.1 suggests that aesthetics and minimalist design could shorten the process lead-time. The following section describes how the different experience level of users and good aesthetics can contribute to shorten process lead-time.

Handling Fields, buttons, tabs and matrix table in window / User interface

The interface is the core to good usability. Both the new users and experienced users had comments on fields, buttons, tabs and matrix in the window. They all agreed that user interface played an important role in their regular work. However, the experienced users did not agree that it is a high priority in the software. One user with 15 years of experience said that:

"I don't care much about the user interface is as long as I know and can do my operations. After working with the system for a while you get accustomed to all the inconvenience and you don't realize it. It doesn't matter anymore".

On the other hand, one user with 3 months of experience shared his opinion that:

"The interface is so bland and confusing. It makes me go in circles before I complete my work. I almost never know what I should do, especially when I encounter a new problem".

6

Discussion

In this section the results of section 5 are discussed along with the related research literature. Section 6.1 discusses the first research question - impact of usability on process lead-time in information systems. Section 6.2 focuses on discussing the second research question - to what extent does the experience level of the users, impact usability on process lead-time in information systems. In each of these sections, the authors have discussed the answers to research questions based on Nielsen's five usability factors to derive a set of key points with maximum explanatory power. However, it is not possible to draw a clear demarcation between the categories as they are closely associated with each other. All five categories complement each other to provide a better discussion on impact of usability.

6.1 RQ1 - Impact of usability on process lead-time in information systems

In this section results from this thesis along with the related research literature are discussed for RQ1 which is impact of usability on process lead-time in information systems.

6.1.1 Learnability

The findings from interview and think aloud method indicate that the learnability factor of usability has an impact on process lead-time in information systems. All 29 subjects agreed that learnability of the system has influence on their daily work. Similarly, Ziefle [73] stated that learnability is concerned with features that allow users to understand easily how to handle a special system and how to improve the performance level quickly.

The users of the system under study mentioned how hard it is for them to work with only codes and numbers and they prefer to have more visual representations. This implies that users can have a better understanding of the system when information is provided in formats that are closer to reality. In addition, Tanimoto [63] claims that visual representations are easier to learn and they increase learnability. Therefore, systems that benefit from visual formats are more understandable and help users to learn faster and more efficient.

The system needs to be consistent throughout its entire platform and follow a standard design pattern. This emphasizes on the importance of following a consistent platform based on GUI standard as also suggested by Nielsen [50], to reduce users' mistakes and shorten lead-time process in information systems. In addition, it is important to conserve consistency in all existing words, situations, or actions in the system. Having some features available in one part and not available in other parts makes the users get lost, and time is wasted before they can figure out that the feature they are looking for is not in that particular part of the system.

Results from interview and think aloud methods depict that having definite words, situation or actions helps in increasing the learnability of the system. Obscure words cause a delay upon users' performance, since they would need to spend some time on clarifying the terms. In addition, if words, situation or actions are not clear enough, the chance of users making mistakes due to misunderstanding escalates. This means, they would have to spend extra time to recover from their mistakes and causing a delay in their work process.

The results from interview and think aloud methods indicate that the complex PDM Logic of the system has a lot of impact on users daily work. Due to lack of knowledge and understanding of the PDM Logic, users make a lot of mistakes or get confused and lost in the systems easily. Interestingly, it was also observed in the survey results that there are a majority of respondents who presume that PDM Logic is complex. In addition, a test for significance showed that there is a significant correlation between the complexity of tasks and time taken. This can be interpreted as the more complex the task is the more time is needed to accomplish it. Correspondingly, reducing the complexity can shorten the process lead-time; therefore, it can infer that complexity can be reduced by providing more support, like help documentation to assist users learn easier, faster and more efficient. Similarly, Leutner [40] found that complexity of a system's logic confronts users with severe psychological problems concerning the learnability and the usability of the software which can be helped by initially providing learning material with easy practice problems and detailed description of how to go about it.

The survey responses to "suggested help features" show that respondents found most of the suggestions useful. This implies that, there is an inherent need for more help documents. Results from interview and think aloud methods also show that help support provided by the system plays an important role in accelerating learnability of that system. The time that is spent on learning the system can depend on how well the help support is organized. Similarly, Nielsen [46] claims that information provided in help documents should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large. Interviewees complained about how the existing help documents were not very understandable and it was not easy for them to search and find information in the documents;

therefore, they seek for help from others. The time that users spend going around, asking for help from their colleagues can be reduced by offering them an efficient source of help documentation. In addition, it was deduced from the interview and think aloud methods that efficient e-learning and training was necessary, the same was confirmed in survey as well.

6.1.2 Efficiency

The results from interview and think aloud methods depict that the efficiency factor of usability has an impact on process lead-time in information systems. 27 subjects accepted that efficiency of the system has an influence on the pace of their daily work. Also, Nielsen [47] claims that efficiency is about how quickly users learn the design and how fast they can perform the tasks.

The findings from interview and think aloud methods indicate that notifications affect the efficiency of the users. Notifications are to help users to analyze and trust the system [61]; therefore these messages must be at a vantage point such that it is hard to miss. A user must be able to naturally look at these messages and make sense out of them. Being able to know and understand notifications reduces the amount of time they take to check for success of their actions. Likewise Bowie [7] found that delivering the user with information about the status of the system enabled them to quickly produce desired results without impacting accuracy or wasting time, actions, and/or resources.

The finding from interview and think aloud methods depicts that having multiple windows opened simultaneously in the system can shorten process lead-time, if handled efficiently. Multiple windows help the users to work in different windows and compare them without having to constantly switch between the windows. On the other hand, having them all open in the menu bar makes the user anxious about which window they were really working on.

From the results of interview and think aloud methods, it was evident that users preferred to tailor the search to retrieve the information. Similarly, Weitz [69] mentions that users expect the search to be insightful and predictive. Being able to tailor their search by adding or removing attributes, they can retrieve relevant information fast, which accelerates making judgments and decisions [69]. They believed it was necessary to have a search feature in all windows which would enable them to directly point to the context of interest and save time searching them manually.

It was observed from the results of interview and think aloud methods that right click shortcuts accelerate velocity of user's performance. Right click shortcuts support the user not to have to navigate to a different location to open up the context regarding a specific object. In this way, right click shortcuts helps the users to navigate and operate faster in the system.

6.1.3 Memorability

The findings from interview and think aloud methods indicate that the memorability factor of usability has an impact on process lead-time in information systems. All 29 subjects agreed that memorability of the system plays an important role in their daily work progress.

The results from interview and think aloud methods revealed that instruction of use can prevent users from making mistakes due to lack of knowledge and save users from wasting time on figuring out the purpose of each object, action and option in the system. In addition, the results from the survey show that KOLA is not self-explanatory as 64% of respondents disagreed that KOLA is self-explanatory system. Also, it was mentioned several times by the subjects that displaying a short text when the mouse pointer is placed over the labels, buttons and text fields can make KOLA self-explanatory and enable them to work more efficiently. Also, 92% of the respondents of the survey confirmed that mouse hovering feature is useful.

The findings from interview and think aloud methods depict that visibility of objects, actions and options reduces the need to memorize and gives the users a better control over the system. Similarly, Yusuf [72] presents that the system must support the user to locate the objects and commands without having them to remember. All 29 participants mentioned about how poor visibility of the system makes users spend a lot of time looking for features they need. Also, not being able to see or find the required features, users take another approach which leads to spending more time accomplishing their task compared to when they could have benefited from the unseen feature. With high visibility, users can find features they need quickly and spend much less time. This was also confirmed in Norman's [51] findings.

6.1.4 Errors

The assessment in error factor proved that errors have an impact on process lead-time for information systems. 25 of the total number of participants from the interviews agreed that errors in the system have influence on their daily work and they are inevitable. Henneman [28] states that a system with poor usability can result in long task times, high numbers of errors, large support costs and long training times. Also, from the results of interview and think aloud methods, it was noticed that the important factors to consider while designing a system with respect to errors are why the errors are made, how many errors do users make, how severe are these errors, and how easily can the user recover from the errors? Upon getting a good understanding of which part of the system has most errors, it will be possible to detect the areas that need to be engineered and designed in a way such that the users would commit fewer mistakes. Similarly, Fields [20] states that, identifying which errors have the most significant impact, provides us with the information to focus on designing which areas deserve the most attention for error prevention.

In the survey results, 86% of the respondents agreed that the design should include step by step guidance by the system, where the system does not let the user to have any opportunity to make mistakes. This step by step guidance drives the user to perform efficiently and helps in making decisions quickly. Further if the users still commit a mistake, the system must handle this mistake in some way as handling errors prevents the user from rework and reduces the overall process lead-time. Otherwise the user might end up having to start the task all over again leading to double the amount of time it might originally take. Similarly, Brown [9] states that to avoid such situations, system must provide the user with an informative and accurate warning message or a comprehensible error message to prevent the user from making a mistake and inform the user of the mistake so they can quickly fix it before the error escalates and consumes more time to fix. A good warning or error message must be short, concise and visible. Also, Nielsen [48] confirms that "good error messages must be polite, precise, and constructive". It must be attractive enough to make the user really read the message and pay attention to it.

6.1.5 Satisfaction

The findings of interview and think aloud methods indicate that the satisfaction factor of usability has slight impact on process lead-time in information systems. It was mentioned in the interviews that how fields, buttons, tabs, matrix table or generally user interface features did not concern the users as much. They believed that information systems have a very specific and formal use, and there is no need for the system to have a fancy or attractive interface. They thought that the old and professional look of the system was good enough. However, on discussing this aspect for a while, it was brought to the researchers notice that, the satisfaction of the overall performance of the system was still influenced by these features. No matter how unimportant the users felt about personalization or having a design similar to the current trends with high satisfaction factor, they highly valued the functionalities like 'user defined menu'. Interestingly, this adds to the results of Yusaf [72]. They mentioned that this type of features helped them to navigate quickly to a specific menu of their choice with just a click. Some others also mentioned that these menus make the system feel personalized and that this part of the system belongs to them. Frøkjær [24] states that there is direct correlation between satisfaction and efficiency. This was confirmed when the results showed that satisfaction with the interface helps the user to be more focused, effective and efficient in their daily work. It was clear from the results of interview and think aloud methods that system integration with other software affect user's work process. The users were complaining about how they have to spend so much time on inputting the same data in two different software. Confirming Fields' [20] results, it was noticed that a lot of time is saved when systems are integrated since users can input only once and access the data in both systems. Also, the possibility of making mistakes and inputting inconsistent data in different systems is reduced. In addition, providing direct link from one system to a relevant part of another system saves users from spending extra time on opening the second system and navigating to the part they want.

6.2 RQ2 - To what extent does the experience level of the users, impact usability on process lead-time in information system

In this section results from this thesis along with the related research literature are discussed for RQ2 which is about to what extend level of users' experience, impact usability on process lead-time in information systems.

6.2.1 Learnability

Similar to the discussions of Alexander [1], the results from the interview and think aloud methods show that providing consistency and standards as well as definite words, situations and actions in the system help experienced users to learn faster a part of the system that they hadn't encountered before, compared to new users learning different parts of the system for the first time. This could be due to familiarity with interface, terminology, and the experience they have gained from working in other parts of the system which is also proposed by Kieras & Polson [37].

A comparative chart shows that, the higher the number of hours a user spends, the more experience they gain in KOLA; the more they believe that the PDM Logic is complex. This could be explained similar to Alexander's [1] explanation on how the experienced users have a good understanding of the system, its functionalities and the rules which enables them to identify the root cause of the problem. However, the new users' knowledge is shallow and limited which makes it hard for them to determine the problem areas.

6.2.2 Efficiency

It was observed from the results of interview and think aloud methods that the experienced users located the notification messages much more easily than the new users. This could be due the extent of time they have worked with the system and the opportunity they had to explore more and familiarize with the layout of the system to spot notification messages.

As discussed in section 6.1.2 handling multiple windows can be tricky similar to the issue presented by Yusuf [72]; however, experienced users benefit from the multiple windows much more than new users. This can be interpreted as a fact that experienced users have a familiarity of the system and can distinguish between the different windows better and would not spend as much time to switch between windows. However, the new users need much more time to get the visual layout registered in their head. This slows them down as they have to identify the window they need.

From the results of interview and think aloud methods, it was noticed that the experienced users are more aware of the unseen search features in different parts of the system due to the years of experience and they benefit from them to work more efficiently. Also, some type of data can be better filtered with attributes, specific type of keyword and wildcards. The experienced users have learnt how to combine these attributes, keywords, and wildcards and filter the data they need due to their experience. However, many new users are struggling to find their data as they are in the process of learning as also explained by Nielsen [46]. Similar to the results of Gerlach [24], the results from the interview and think aloud methods indicate that experienced users use fewer steps and have higher productivity. This could be due to the fact that experienced users have tried several ways to achieve a task over time. There is a possibility to perform the same task in different ways and no strict rule exists to confirm which is the most efficient or the fastest. Similar to observations of Alexander [1], the new users are often confused and cannot remember which sequence of steps they had taken the last time. Interestingly, these suggestions are similar to propositions placed by Kieras and Polson [37] which explains the complexity of a system, from the point of view of a user and the way a system should be designed to reduce the complexity for the user. Another surprising result observed from the survey is that, there is no correlation between the experience of a user and the time he/she takes to perform it. An explanation to this phenomenon could be that, experienced users spend sufficient time to check through all the steps needed to accomplish the tasks as they are aware of the steps to the checking process and understand the severity of its implications. However, new users might miss performing these steps to the checking process as they are not aware of the necessary steps or know the importance of it and finish the tasks faster.

6.2.3 Memorability

The results from interview and think aloud methods depict that instruction of use have impact on the time new users spend to accomplish a task compared to experienced users. Users who are new to the system can benefit from the instructions of use to gain a better understanding of each object, action and option in the system to perform faster and make fewer mistakes. However, the experienced users don’t need these instructions as much, since they are more familiar with the system and have gained the required skills. This finding was considerably similar to the finding of Alexander [1]. Also, it is good to consider an activating and deactivating option for this feature so that users, especially experienced users, are not disturbed during their work process with these instructions while having the opportunity to activate the feature by choice.

From the results of interview and think aloud methods it was evident that experienced users were more aware of the existing objects, actions and options. Similar to Nielsen’s [47] findings, it was also deduced from the results that, experienced users are benefitted from these accelerators as they provide support to perform faster. However, the new users are not fully benefitted from these accelerators as they are usually unseen and hidden. Being aware of these accelerators speeds up experienced user work and enables them to be more efficient.

6.2.4 Errors

Error prevention can dramatically reduce maintenance costs, increase team efficiency, and facilitate the system/software changes that are required to stay competitive in today's market [38]. The results show that a careful design prevents a problem from occurring in the first place. It was also confirmed by Nielsen [47] that it is needed to eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action. From the results it was noticed that the new users appreciate a legible confirmations more than experienced users. Similarly, Nielsen [46] suggests that the design of error and warning messages must be clear, precise and comprehensible. The experienced users do not see unclear messages as a decelerator as they are familiar with the system and can detect or understand the meaning of these error messages.

The experienced users make fewer mistakes and require lesser system support to prevent them from making mistakes. Often they agree that these system control and checks speeds them up. Even as experienced users, if they do not need to manually check everything and if a system would do the check on their behalf instead, they could save a lot time and effort. Interestingly, it was also deduced from the survey results that, the experienced users believe that feedback information like notification and errors can be beneficial to all. Also, it was observed that new users benefit from better notifications and error feedback. If the system can warn them about their faults before they hit submit, they save much more time by going back and fixing it than having to realize after the damage has been done.

6.2.5 Satisfaction

Satisfaction is the users' comfort and positive attitudes towards the use of the system [21]. The results from interview and think aloud methods show that the impact of satisfaction on process lead-time was considered more by new users than experienced users. Experienced users who had been working in the company for many years had become so used to the system that they couldn’t see the faults and drawbacks. Also, working with the same system over years had minimized the opportunity of experiencing other systems and being able to compare and differentiate. In addition, they were satisfied with the system and they resisted to any changes since they are experts of the system as it is today and any changes meant losing their advantage. On the other hand, new users, with fresh mindset, had comments about how user interface has an impact on their daily work and slows them down. Similar to the results of Yusuf [72] who describes about how having nested forms makes the screen chaotic, it was observed in the results that the white and the light gray color used in the matrix table makes it hard for them to distinguish between columns or having a lot of fields arranged close to each other in a window makes it difficult for them not to miss inputting fields; therefore, they spend more time trying to handle these hindering interfaces.

7

Conclusion

This study set out to identify the impact of usability on process lead-time in information systems and to what extent the level of experience of users' impacts usability on process lead-time in information systems. By performing 29 interviews, 17 think aloud sessions, 5 documents study, 1 workshop and 1 survey with 73 responses, impacts of usability on process lead-time (see section 5.2) and influence of level of experience (see section 5.3) in information systems were identified.

In relation to RQ1 - impact of usability on process lead-time in information systems, the most salient results include: 1) Learnability factor of usability has an impact on process lead-time. The time needed to learn a system can be influenced by this factor. Also, how well a system provides additional help and support along with the level of complexity of the logic behind the system affects process lead-time. 2) Efficiency factor of usability plays a role on the time users spend on their daily work. System providing accelerators can influence the velocity of the user's performance. 3) A noticeable portion of process lead-time can be explained by memorability factor. Level of visibility of objects, actions and options, as well as quality of instruction of use has an impact on users' performance. 4) Errors as a factor of usability has an impact on process lead-time. The way a system is designed to guide users to commit fewer mistakes and implement system controls and checks can have an impact on the time users spend to accomplish their daily work. 5) Satisfaction has a slight impact on process lead-time. The design of system's interface and its integration to other systems have an influence on the way users work.

Impact of usability on different matters such as market share and safety of critical systems has been mentioned in previous literature; however, this study also identified the impact usability has on process lead-time in information system. To the authors' best knowledge, there is currently a lack of research in this regard.

The findings regarding RQ2 - to what extent the level of experience of users impact usability on process lead-time in information system, the most prominent results are: 1) Learnability factor has slight impact on process lead-time with respect to level of experience, after learning one part of the system it is easier to learn other parts. 2) Efficiency factor has a high impact on performance of users with different levels of experience. Level of experience determines effective utilization of accelerators thereby affecting the process lead-time. 3) Level of experience of a user influences the impact memorability has on process lead-time. Level of visibility of objects, actions and options, as well as quality of instruction of use has a greater impact on process lead-time for less experienced users compared to more experienced user. 4) Impact of the Error factor on process lead-time, such as error preventions and system controls, is influenced by users' level of experience. 5) Satisfaction of the system has different degree of impact when system is used by users with various levels of experience. Interface of the system plays a minor role on process lead-time for experienced users as they become accustomed to it when compared to new users.

The relationship between usability and level of users' experience has been covered in previous studies; however, to what extent the level of experience of users impact usability on process lead-time in information system is not covered.

Considering the results, each of the five usability factors have impact on process lead-time in information system, it can be concluded that usability plays an important role in shortening process lead-time in information systems, especially with regards to level of experience of users.

7.1 Implications for practitioners

This study presents a set of elements that determine the impact of usability on process lead-time in information systems. These elements can be used as a checklist by companies to shorten their process lead-time in information systems. Also, this thesis gives organizations an insight into how level of experience of user influences the impact usability has on process lead-time. By considering the levels of experience and how it affects the process lead-time, several business decisions can be made. For e.g., the company can decide when and how the usability changes can be implemented with regard to number of new or experienced users and the impact each group imposes on the process lead-time.

7.2 Contributions to academic research

This thesis adds to the existing body of academic knowledge within software engineering. Not only does this study address the lack of research material on the impact of usability on process lead-time in information systems, it also adds additional value by discussing its effects based on levels of experience. The relevant findings are presented in section 5.2 and section

5.3. According to researchers' best knowledge, there has not be a mapping between the usability factors and usability heuristics of Nielsen [54], and an earnest attempt has been made to define broad guidelines to consider both factors and heuristics. It is believed by the researchers that these mappings serve as an outline for designer to consider which areas need to have high focus when they study the impact of usability. For instance, if designers want to study learnability factor of a system, it is recommended to focus on "Match between system and real world", "Consistency and standard" and "Help and Documentation" heuristics (See table 5.1). Though previous studies have covered the impact of usability in information systems based on usability factors or usability heuristics separately, this thesis demonstrates the need to consider mapping both factors and heuristics to gain a better focus on studying usability.

7.3 Future work

This case study focused on studying a single company; however, it would be interesting to involve several companies to validate the results of this thesis. These further studies provide an opportunity to determine whether the results can be generalized. It would also be beneficial to further investigate how to improve the usability to reduce lead-time in information systems and potentially develop a set of guidelines for identifying problems, observing the effect and suggesting improvements that can be tested and validated in industry.

Finally, looking at the importance of usability studies it would be beneficial to develop metrics to measure the impact of usability on process lead-time. These metrics are important as they would be accurate measurements about how the process is functioning and provide base to suggest improvements.

References

[1] Alexander, M., & Chen, H. L. (2003). Perceptions and effects of a system's usability by experience level. *Proceedings of the American Society for Information Science and Technology*, *40*(1), 389-397.

[2] Al Jerjawi, K. (2012). Methods of statistical analysis: an overview and critique of common practices in research studies. *International Journal of Liability and Scientific Enquiry*, *5*(1), 32-36.

[3] Allen, B. (1994). Cognitive abilities and information system usability. *Information processing & management*, *30*(2), 177-191.

[4] Alroobaea, R., & Mayhew, P. J. (2014, August). The impact of usability on e-marketing strategy in international tourism industry. In *Science and Information Conference (SAI), 2014* (pp. 961-966). IEEE.

[5] Bolboacă, S. D., Jäntschi, L., Sestraş, A. F., Sestraş, R. E., & Pamfil, D. C. (2011). Pearson-Fisher chi-square statistic revisited. *Information*, *2*(3), 528-545.

[6] Bornoe, N., & Stage, J. (2014). Usability Engineering in the Wild: How Do Practitioners Integrate Usability Engineering in Software Development?. In*Human-Centered Software Engineering* (pp. 199-216). Springer Berlin Heidelberg.

[7] Bowie, J. (2012). Sound usability?. *Commun. Des. Q. Rev*, 13(2), pp.15-24.

[8] Brink, H. I. L. (1993). Validity and reliability in qualitative research. *Curationis*,*16*(2), 35-38.

[9] Brown, P. J. (1983). Error messages: the neglected area of the man/machine interface. *Communications of the ACM*, *26*(4), 246-249.

[10] Burke, L. A., & James, K. E. (2006). Using online surveys for primary research data collection: lessons from the field. *International journal of innovation and learning*, *3*(1), 16-30.

[11] Bygstad, B., Ghinea, G., & Brevik, E. (2008). Software development methods and usability: Perspectives from a survey in the software industry in Norway.*Interacting with computers*, *20*(3), 375-385.

[12] Cape, P. (2010). Questionnaire length, fatigue effects and response quality revisited. *Survey Sampling International*.

[13] Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2013). *Applied multiple regression/correlation analysis for the behavioral sciences*. Routledge.

[14] Darke, P., Shanks, G., & Broadbent, M. (1998). Successfully completing case study research: combining rigour, relevance and pragmatism. *Information systems journal*, *8*(4), 273-289.

[15] Denzin, N. K. (1970). *The research act: A theoretical introduction to sociological methods*. Transaction publishers.

[16] Djordjevic, N. D., Rancic, D. D., & Vulic, I. (2013, October). The relative importance of the usability factors for web portals. In *Telecommunication in Modern Satellite, Cable and Broadcasting Services (TELSIKS), 2013 11th International Conference on* (Vol. 2, pp. 571-574). IEEE.

[17] Earley, S. (2014). Usability for Internal Systems: What's the Payoff?. *IT Professional*, *16*(5), 66-69.

[18] Eskelin, A. (2001). *Technology acquisition: buying the future of your business*. Pearson Education.

[19] Fetterman, D. M. (1986). General/Theoretical Anthropology: Ethnography and Qualitative Design in Educational Research. Judith Preissle Goetz and Margaret Diane LeCompte. *American Anthropologist*, *88*(3), 764-765.

[20] Fields, B., Wright, P., & Harrison, M. (1996). Time, tasks and errors. *ACM SIGCHI Bulletin*, *28*(2), 53-56.

[21] Frøkjær, E., Hertzum, M., & Hornbæk, K. (2000, April). Measuring usability: are effectiveness, efficiency, and satisfaction really correlated?. In *Proceedings of the SIGCHI conference on Human Factors in Computing Systems* (pp. 345-352). ACM.

[22] Galesic, M., & Bosnjak, M. (2009). Effects of questionnaire length on participation and indicators of response quality in a web survey. *Public Opinion Quarterly*, *73*(2), 349-360.

[23] Gall, M. D., Borg, W. R., & Gall, J. P. (1996). *Educational research: An introduction* . Longman Publishing.

[24] Gerlach, J. H., & Kuo, F. Y. (1991). Understanding human-computer interaction for information systems design. *Mis Quarterly*, 527-549.

[25]Gill, A. M., & Nonnecke, B. (2012, October). Think aloud: effects and validity. In*Proceedings of the 30th ACM international conference on Design of communication* (pp. 31-36). ACM.

[26] Gould, J. D., & Lewis, C. (1985). Designing for usability: key principles and what designers think. *Communications of the ACM*, *28*(3), 300-311.

[27] Hays, W.L. (1963). Statistics. New York, NY: Holt, Reinhart & Winston.

[28] Henneman, R. L. (1999). Design for usability: process, skills, and tools.*Information, Knowledge, Systems Management*, *1*(2), 133-144.

[29] Isa, B. S., Boyle, J. M., Neal, A. S., & Simons, R. M. (1983, December). A methodology for objectively evaluating error messages. In *Proceedings of the SIGCHI conference on Human Factors in Computing Systems* (pp. 68-71). ACM.

[30] ISO 9126. Software Product Evaluation: Quality Characteristics and Guidelines for their Use. 1991

[31] Issa, T., & Turk, A. (2012). Applying usability and HCI principles in developing marketing websites. *Int J Comput Inf Syst Ind Manag Appl*, *4*, 76-82.

[32] Jick, T. D. (1979). Mixing qualitative and quantitative methods: Triangulation in action. *Administrative science quarterly*, 602-611.

[33] Juristo, N., Moreno, A. M., & Sanchez-Segura, M. I. (2007). Analysing the impact of usability on software design. *Journal of Systems and Software*, *80*(9), 1506-1516.

[34] Juristo, N. (2009). Impact of usability on software requirements and design. In*Software Engineering* (pp. 55-77). Springer Berlin Heidelberg.

[35] Karahoca, A., Bayraktar, E., Tatoglu, E., & Karahoca, D. (2010). Information system design for a hospital emergency department: A usability analysis of software prototypes. *Journal of biomedical informatics*, *43*(2), 224-232.

[36] Key, James. 'Chi Square'. *Okstate.edu*. N.p., 2015. Web. 22 May 2015.

[37] Kieras, D., & Polson, P. G. (1985). An approach to the formal analysis of user complexity. *International journal of man-machine studies*, *22*(4), 365-394.

[38] Kolawa, A. K., Hicken, W. T., Hicken, A. R., Kucharski, M., & Brunnell, G. A. (2009). *U.S. Patent No. 7,596,778*. Washington, DC: U.S. Patent and Trademark Office.

[39] Kuhlang, P., Edtmayr, T., & Sihn, W. (2011). Methodical approach to increase productivity and reduce lead time in assembly and production-logistic processes. *CIRP Journal of Manufacturing Science and Technology*, *4*(1), 24-32.

[40] Leutner, D. (2000). Double-fading support—a training approach to complex software systems. *Journal of computer assisted learning*, *16*(4), 347-357.

[41] Marsh, E. E., & White, M. D. (2006). Content analysis: A flexible methodology.*Library trends*, *55*(1), 22-45.

[42] Mayring, P. (2000). Qualitative Content Analysis. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research, 1*(2). Retrieved from http://www.qualitative-research.net/index.php/fqs/article/view/1089/2386

[43] Myers, M. D., & Avison, D. (1997). Qualitative research in information systems. *Management Information Systems Quarterly*, *21*, 241-242.

[44] Namey, E., Guest, G., Thairu, L., & Johnson, L. (2007). Data reduction techniques for large qualitative data sets. *Handbook for team-based qualitative research*, 137-162.

[45] Narahari, Y., Viswanadham, N., & Kumar, V. K. (1999). Lead time modeling and acceleration of product design and development. *IEEE Transactions on Robotics & Automation*, *15*(5), 882-896.

[46] Nielsen, J. (1992). The usability engineering life cycle. Computer, 25(3), 12-22.

[47] Nielsen, J. (1995). 10 Usability Heuristics for User Interface Design. *Fremont: Nielsen Norman Group.[Consult. 20 may 2014]. Available on the Internet*.

[48] Nielsen, J. (2001). Error message guidelines. *Nielsen Norman Group*, 06-24.

[49] Nielsen, J. (2003). Usability 101: Introduction to usability.

[50] Nielsen, J. (2008). OK-Cancel or Cancel-OK? *Fremont: Nielsen Norman Group. Available on the Internet.*

[51] Norman, K. L. (1991). *The psychology of menu selection: Designing cognitive control at the human/computer interface*. Intellect Books.

[52] Orlikowski, W. J., & Baroudi, J. J. (1991). Studying information technology in organizations: Research approaches and assumptions. *Information systems research*, *2*(1), 1-28.

[53] Piccioni, M., Furia, C. A., & Meyer, B. (2013, October). An empirical study of api usability. In *Empirical Software Engineering and Measurement, 2013 ACM/IEEE International Symposium on* (pp. 5-14). IEEE.

[54] Rabionet, S. E. (2011). How I Learned to Design and Conduct Semi-Structured Interviews: An Ongoing and Continuous Journey. *Qualitative Report*, *16*(2), 563-566.

[55] Ragowsky, A., Ahituv, N., & Neumann, S. (1996). Identifying the value and importance of an information system application. *Information & Management*,*31*(2), 89-102.

[56] Rohner, R. P. (1977). Advantages of the comparative method of anthropology.*Cross-Cultural Research*, *12*(2), 117-144.

[57] Romano Jr, N. C., Donovan, C., Chen, H., & Nunamaker Jr, J. F. (2003). A methodology for analyzing web-based qualitative data. *Journal of Management Information Systems*, *19*(4), 213-246.

[58] Runeson, P., & Höst, M. (2009). Guidelines for conducting and reporting case study research in software engineering. *Empirical software engineering*, *14*(2), 131-164.

[59] Seaman, C. B. (1999). Qualitative methods in empirical studies of software engineering. *Software Engineering, IEEE Transactions on*, *25*(4), 557-572.

[60] Shim, J. P., Warkentin, M., Courtney, J. F., Power, D. J., Sharda, R., & Carlsson, C. (2002). Past, present, and future of decision support technology.*Decision support systems*, *33*(2), 111-126.

[61] Sopan, A., Freier, M., Taieb-Maimon, M., Plaisant, C., Golbeck, J., & Shneiderman, B. (2013). Exploring data distributions: Visual design and evaluation. *International Journal of Human-Computer Interaction*, *29*(2), 77-95.

[62] Spiggle, Susan. "Analysis and interpretation of qualitative data in consumer research." *Journal of consumer research* (1994): 491-503.

[63] Tanimoto, S. L. (1997, September). Representation and learnability in visual languages for web-based interpersonal communication. In *Visual Languages, 1997. Proceedings. 1997 IEEE Symposium on* (pp. 2-10). IEEE.

[64] Thompson, I. (2001). Collaboration in technical communication: a qualitative content analysis of journal articles, 1990-1999. Professional Communication, IEEE Transactions on, 44(3), 161-173.

[65] Turner III, D. W. (2010). Qualitative interview design: A practical guide for novice investigators. *The qualitative report*, *15*(3), 754-760.

[66] Van Gog, T., Paas, F., Savenye, W., Robinson, R., Niemczyk, M., Atkinson, R., ... & Hancock, P. A. (2008). Data collection and Analysis. *Handbook of Research on Educational Communications and Technology 3e*, 763-806.

[67] Venable, J. (2011). Incorporating design science research and critical research into an introductory business research methods course. *Electronic Journal of Business Research Methods*, *9*(2), 119-129.

[68] Volvogroup.com,. (2015). *About us - About us : Volvo Group Global*. Retrieved 24 May 2015, from http://www.volvogroup.com/group/global/en-gb/volvo%20group/Pages/aboutus.aspx

[69] Weitz, S. (2014). *Search: How the Data Explosion Makes Us Smarter*. Bibliomotion, Inc..

[70] Yin, R. K. (2013). *Case study research: Design and methods*. Sage publications.

[71] Yuan, W. (1997). End-user searching behavior in information retrieval: A longitudinal study. *Journal of the American society for information science*,*48*(3), 218-234.

[72] Yusuf, S. U., Taslim, J., Adnan, W., Adilah, W., & Baharudin, S. K. (2014, September). Usability evaluation of Human Resource Management Information System (HRMIS). In *User Science and Engineering (i-USEr), 2014 3rd International Conference on* (pp. 204-209). IEEE.

[73] Ziefle, M. (2002). The influence of user expertise and phone complexity on performance, ease of use and learnability of different mobile phones. *Behaviour & Information Technology*, *21*(5), 303-311.

A

Interview Questions

Row	Category	Interview Questions	Research Questions	Type of Users
1	General	Could you please explain your role in the company?	RQ1.1	All
2	General	How long have you been working in the company and how long it is since you have started working with KOLA?	RQ1.1	All
3	General	How many hours a day do you work with KOLA?	RQ1	All
4	General	What do you use KOLA for?	RQ1	All
5	General	How does KOLA affect your daily work?	RQ1.1	All
6	Learnability	Is the system self-explanatory?	RQ1	All
7	Learnability	How easy is it for users to accomplish a task in KOLA for the first time they encounter the system?	RQ1	New users & Key users
8	Learnability	What do you think of the system help support and do you have any suggestions?	RQ1 and RQ2	All
9	Memorability	How well does the system guide you to accomplish your tasks?	RQ1	New users
10	Memorability	How easy is it for users/you to find features or functions in the system?	RQ1	All
11	Efficiency	Once you have learned how the system works, is it quick to perform tasks in KOLA?	RQ1	All
12	Efficiency	In your opinion, does the system provide sufficient feedback on your operations?	RQ1	All
13	Efficiency	Which part is the easiest part for you/users to get used to?	RQ1 and RQ2	New users & Key users
14	Efficiency	Which part is the hardest part for you/users to get used to?	RQ1 and RQ2	New users & Key users
15	Efficiency	What were the reasons that you asked for help	RQ1	New users

		last three times?		
16	Efficiency	What are the main questions that you usually get from other users?	RQ1	Key users
17	Error	How well can users redo or undo their operations, in your opinion?	RQ2	All
18	Error	In your opinion, how well is the system designed to prevent users from making fewer mistakes?	RQ1	All
19	Error	What type of help do you think will assist you/users to perform faster and make fewer mistakes?	RQ2	New users & Key users
20	Errors	Where do you/users make the most mistakes or have problems frequently?	RQ1	All
21	Error	How well does the system support users to recognize, diagnose, and recover from errors, in your opinion?	RQ1	All
22	Satisfaction	What do you suggest to add to the system?	RQ2	All
23	Satisfaction	What do you suggest to remove from the system?	RQ2	All
24	Satisfaction	What would you prefer to be changed in the system?	RQ2	All
25	Satisfaction	What works well in KOLA in your opinion?	RQ1	All
26	Satisfaction	What does not work well in KOLA in your opinion?	RQ1	All
27	Conclusion	Do you have any comments or suggestions related to usability of KOLA?	RQ2	All

B

Survey Questions

* indicates a required field

Gender *

- Femal
- Male

How much time do you spend in KOLA, weekly, in average? *

- 0-30 min
- 30-90 min
- 1 ½-4 hours
- 4-8 hours
- 8-14 hours
- 14-20h
- over 20

How long have you been working with KOLA? *

- 0-6 months
- 7-12 months
- more than 1 year and less than 4 ye
- 4-8 years
- Over 8 years

You are *

- Volvo employee
- Consultant
- Other

What is your role/responsibility? *

- Customer Adaptation
- Production preparation
- User administrator
- DCN specialist
- Project leader
- Design engineer
- Project support
- Design reviewer
- Technical Authorization
- Other

Are you a KOLA Key user? *

- Yes
- No
- I don't know who a key user is!

KOLA is self-explanatory (It can be used without additional help or training) *

- Strongly Agree

- Agree
- Neither agree nor disagree
- Disagree
- Strongly Disagree

The feedback information in KOLA is satisfactory. (Error and Notification) *

- Strongly Agree
- Agree
- Neither agree nor disagree
- Disagree
- Strongly Disagree

In your opinion, what features work well in KOLA and why?

During what tasks do you think the most mistakes are made in KOLA and why?

From 1 to 5, please rank the usefulness of the proposed help features: *

	Not useful 1	2	Useful 3	4	Extremely useful 5	No opinion
An updated list of FAQ	○	○	○	○	○	○
On placing mouse pointer display additional information (with the possibility of deactivating)	○	○	○	○	○	○
A help button in the window (as it works today)	○	○	○	○	○	○
A help section inside the window	○	○	○	○	○	○
Tip of the day (with the possibility of deactivating)	○	○	○	○	○	○

How much time would it take to perform the following tasks, in average?

	Less than 5 minutes 1	2	10-15 minutes 3	4	More than 20 minutes 5	N/A
Create DCN	○	○	○	○	○	○
Create and release an item	○	○	○	○	○	○
Create Item/Variant link	○	○	○	○	○	○
Select your variant combination while you are creating an Item/Variant link	○	○	○	○	○	○
Check variant authorizations(product type) while you are creating an	○	○	○	○	○	○

Item/Variant link						
Check variant restrictions while you are creating an Item/Variant link	○	○	○	○	○	○

From 1 to 5, please rank the complexity of the following tasks? *

	Not complex 1	2	Complex 3	4	Extremely complex 5	N/A
Creating DCN	○	○	○	○	○	○
Creating and releasing an item	○	○	○	○	○	○
Creating Item/Variant link	○	○	○	○	○	○
Selecting your variant combination while you are creating an Item/Variant link	○	○	○	○	○	○
Checking variant authorizations(product type) while you are creating an Item/Variant link	○	○	○	○	○	○
Checking variant restrictions while you are creating an Item/Variant link	○	○	○	○	○	○

How useful do you think it is, if the system could guide users step by step through the process of creating Item/Variant link? (with the possibility of deactivating) *

- Extremely useful
- very useful
- Useful
- Slightly useful
- Not useful

Which of the following is hard to understand in KOLA, in your opinion? *

- PDM Logic and the business rules
- User Interface
- Both
- None

To what extent does KOLA's current usability (ease of use and learnability) have an impact on your daily work? *

- It extremely speeds up my work
- It speeds up my work
- It doesn't have any effect
- It slows down my work
- It extremely slows down my work

How can the ease of use and learnability in KOLA be improved? (Multiple answers possible!)

- Improve user interface
- Make KOLA more intuitive
- Increase training and e-learning material
- Improve help and support

- [ ] Modify the logic behind KOLA and make it easier
- [ ] Improve integration of KOLA with other systems

Do you have any suggestions to make KOLA more user friendly?

C

Statistical Analysis

The following tables depict the results from statistical analysis performed on the survey responses. Columns X and Y show the variables of the analysis. Further, Sig. and Asymp. Sig. columns stand for significance and asymptotic significance respectively, and show whether there is a significant association between the two variables or not. The last column explains the significant correlation between the two variables. X variable explains R Square * 100 percent of the variance in Y variable. B constant and B are unstandardized coefficients which are regression coefficients representing the mean change in the response variable for one unit of change in the predictor variable while holding other predictors in the model constant. The regression equation - $\hat{Y}$ = B(X) + B constant - describes the statistical relationship between the two variables. B constant and B are unstandardized coefficients.

For example, the correlation between respondents' satisfaction about feedback information in KOLA and years of experience of respondents in KOLA is significant. Years of experience of respondents explains 8.6% of the variance in respondents' satisfaction about feedback information in KOLA. In addition, unit change in the years of experience of respondents changes the respondents' satisfaction about feedback information in KOLA in a linear manner which is as respondents' satisfaction about feedback information in KOLA = 0.086 + 2.238 (years of experience of respondents in KOLA).

			KOLA is self explanatory (It can be used without additional help or training)					
			Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Total
How much time do you spend in KOLA, weekly, in average?	0 to 4 hours	Count	7	9	4	6	0	26
		Expected Count	7.8	8.9	5.0	3.9	.4	26.0
	4 to 20 hours	Count	5	9	5	2	0	21
		Expected Count	6.3	7.2	4.0	3.2	.3	21.0
	over 20 hours	Count	10	7	5	3	1	26
		Expected Count	7.8	8.9	5.0	3.9	.4	26.0
Total		Count	22	25	14	11	1	73
		Expected Count	22.0	25.0	14.0	11.0	1.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.817[a]	8	.668
Likelihood Ratio	5.974	8	.650
Linear-by-Linear Association	.407	1	.523
N of Valid Cases	73		

a. 9 cells (60.0%) have expected count less than 5. The minimum expected count is .29.

Figure C.1: Regression analysis between KOLA being self-explanatory and average amount of time spent in KOLA weekly.

			KOLA is self explanatory (It can be used without additional help or training)					
			Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree	Total
How long have you been working with KOLA?	Less than 8 years	Count	7	11	5	5	0	28
		Expected Count	8.4	9.6	5.4	4.2	.4	28.0
	Over 8 year	Count	15	14	9	6	1	45
		Expected Count	13.6	15.4	8.6	6.8	.6	45.0
Total		Count	22	25	14	11	1	73
		Expected Count	22.0	25.0	14.0	11.0	1.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.632[a]	4	.803
Likelihood Ratio	1.979	4	.740
Linear-by-Linear Association	.107	1	.743
N of Valid Cases	73		

a. 3 cells (30.0%) have expected count less than 5. The minimum expected count is .38.

Figure C.2: Regression analysis between KOLA being self-explanatory and years of experience.

			The feedback information in KOLA is satisfactory. (Error and Notification)			Total
			Disagree	Neither agree nor disagree	Agree	
How much time do you spend in KOLA, weekly, in average?	0 to 4 hours	Count	5	6	15	26
		Expected Count	8.5	6.4	11.0	26.0
	4 to 20 hours	Count	9	5	7	21
		Expected Count	6.9	5.2	8.9	21.0
	over 20 hours	Count	10	7	9	26
		Expected Count	8.5	6.4	11.0	26.0
Total		Count	24	18	31	73
		Expected Count	24.0	18.0	31.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.651[a]	4	.325
Likelihood Ratio	4.757	4	.313
Linear-by-Linear Association	3.084	1	.079
N of Valid Cases	73		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.18.

Figure C.3: Regression analysis between feedback information in KOLA being satisfactory and average amount of time spent in KOLA weekly.

			The feedback information in KOLA is satisfactory. (Error and Notification)			Total
			Disagree	Neither agree nor disagree	Agree	
How long have you been working with KOLA?	Less than 8 years	Count	12	10	6	28
		Expected Count	9.2	6.9	11.9	28.0
	Over 8 year	Count	12	8	25	45
		Expected Count	14.8	11.1	19.1	45.0
Total		Count	24	18	31	73
		Expected Count	24.0	18.0	31.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.362[a]	2	.015
Likelihood Ratio	8.740	2	.013
Linear-by-Linear Association	5.791	1	.016
N of Valid Cases	73		

a. 0 cells (0.0%) have expected count less than 5. The

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.294[a]	.086	.074	.878

a. Predictors: (Constant), How long have you been working with KOLA?

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	2.238	.357		6.275	.000
	How long have you been working with KOLA?	.548	.211	.294	2.592	.012

a. Dependent Variable: The feedback information in KOLA is satisfactory. (Error and Notification)

Figure C.4: Regression analysis between feedback information in KOLA being satisfactory and years of experience.

			How much time would it take to perform the following tasks, in average? _Create DCN						
			Not Applicable	Less than 5minutes	5-10 minutes	10-15 minutes	15-20 minutes	More than 20 minutes	Total
How much time do you spend in KOLA, weekly, in average?	0 to 4 hours	Count	1	11	3	8	2	1	26
		Expected Count	1.4	12.1	3.6	5.7	1.4	1.8	26.0
	4 to 20 hours	Count	0	10	5	3	2	1	21
		Expected Count	1.2	9.8	2.9	4.6	1.2	1.4	21.0
	over 20 hours	Count	3	13	2	5	0	3	26
		Expected Count	1.4	12.1	3.6	5.7	1.4	1.8	26.0
Total		Count	4	34	10	16	4	5	73
		Expected Count	4.0	34.0	10.0	16.0	4.0	5.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	10.699[a]	10	.381
Likelihood Ratio	12.491	10	.254
Linear-by-Linear Association	.535	1	.465
N of Valid Cases	73		

a. 13 cells (72.2%) have expected count less than 5. The minimum expected count is 1.15.

Figure C.5: Regression analysis between amount of time it takes to create a DCN and average amount of time spent in KOLA weekly.

			How much time would it take to perform the following tasks, in average? _Create DCN						
			Not Applicable	Less than 5minutes	5-10 minutes	10-15 minutes	15-20 minutes	More than 20 minutes	Total
How long have you been working with KOLA?	Less than 8 years	Count	1	13	4	7	1	2	28
		Expected Count	1.5	13.0	3.8	6.1	1.5	1.9	28.0
	Over 8 year	Count	3	21	6	9	3	3	45
		Expected Count	2.5	21.0	6.2	9.9	2.5	3.1	45.0
Total		Count	4	34	10	16	4	5	73
		Expected Count	4.0	34.0	10.0	16.0	4.0	5.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.818[a]	5	.976
Likelihood Ratio	.852	5	.974
Linear-by-Linear Association	.044	1	.835
N of Valid Cases	73		

a. 7 cells (58.3%) have expected count less than 5. The minimum expected count is 1.53.

Figure C.6: Regression analysis between amount of time it takes to create a DCN and years of experience.

			How much time would it take to perform the following tasks, in average? _Create and release an item						
			Not Applicable	Less than 5 minutes	5-10 minutes	10-15 minutes	15-20 minutes	More than minutes	Total
How much time do you spend in KOLA, weekly, in average?	0 to 4 hours	Count	1	5	5	9	4	2	26
		Expected Count	2.1	5.3	3.9	8.5	2.1	3.9	26.0
	4 to 20 hours	Count	1	5	3	8	1	3	21
		Expected Count	1.7	4.3	3.2	6.9	1.7	3.2	21.0
	over 20 hours	Count	4	5	3	7	1	6	26
		Expected Count	2.1	5.3	3.9	8.5	2.1	3.9	26.0
Total		Count	6	15	11	24	6	11	73
		Expected Count	6.0	15.0	11.0	24.0	6.0	11.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.276[a]	10	.602
Likelihood Ratio	8.068	10	.622
N of Valid Cases	73		

a. 13 cells (72.2%) have expected count less than 5. The minimum expected count is 1.73.

Figure C.7: Regression analysis between amount of time it takes to create and release an item and average amount of time spent in KOLA weekly.

			How much time would it take to perform the following tasks, in average? _Create and release an item						
			Not Applicable	Less than 5 minutes	5-10 minutes	10-15 minutes	15-20 minutes	More than minutes	Total
How long have you been working with KOLA?	Less than 8 years	Count	2	7	3	8	2	6	28
		Expected Count	2.3	5.8	4.2	9.2	2.3	4.2	28.0
	Over 8 year	Count	4	8	8	16	4	5	45
		Expected Count	3.7	9.2	6.8	14.8	3.7	6.8	45.0
Total		Count	6	15	11	24	6	11	73
		Expected Count	6.0	15.0	11.0	24.0	6.0	11.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.613[a]	5	.759
Likelihood Ratio	2.598	5	.762
N of Valid Cases	73		

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is 2.30.

Figure C.8: Regression analysis between amount of time it takes to create and release an item and years of experience.

			How much time would it take to perform the following tasks, in average? _Create Item/Variant link						
			Not Applicable	More than 5 minutes	5-10 minutes	10-15 minutes	15-20 minutes	More than 20 minutes	Total
How much time do you spend in KOLA, weekly, in average?	0 to 4 hours	Count	1	9	1	9	5	1	26
		Expected Count	2.8	8.5	3.2	7.1	2.8	1.4	26.0
	4 to 20 hours	Count	1	8	3	6	2	1	21
		Expected Count	2.3	6.9	2.6	5.8	2.3	1.2	21.0
	over 20 hours	Count	6	7	5	5	1	2	26
		Expected Count	2.8	8.5	3.2	7.1	2.8	1.4	26.0
Total		Count	8	24	9	20	8	4	73
		Expected Count	8.0	24.0	9.0	20.0	8.0	4.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.865[a]	10	.231
Likelihood Ratio	13.173	10	.214
N of Valid Cases	73		

a. 12 cells (66.7%) have expected count less than 5. The minimum expected count is 1.15.

Figure C.9: Regression analysis between amount of time it take to create an Item/Variant link and average amount of time spent in KOLA weekly.

			How much time would it take to perform the following tasks, in average? _Create Item/Variant link						
			Not Applicable	More than 5 minutes	5-10 minutes	10-15 minutes	15-20 minutes	More than 20 minutes	Total
How long have you been working with KOLA?	Less than 8 years	Count	4	10	3	8	1	2	28
		Expected Count	3.1	9.2	3.5	7.7	3.1	1.5	28.0
	Over 8 year	Count	4	14	6	12	7	2	45
		Expected Count	4.9	14.8	5.5	12.3	4.9	2.5	45.0
Total		Count	8	24	9	20	8	4	73
		Expected Count	8.0	24.0	9.0	20.0	8.0	4.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.180[a]	5	.672
Likelihood Ratio	3.561	5	.614
N of Valid Cases	73		

a. 7 cells (58.3%) have expected count less than 5. The minimum expected count is 1.53.

Figure C.10: Regression analysis between amount of time it takes to create an Item/Variant link and years of experience.

			How much time would it take to perform the following tasks, in average? _Select your variant combination while you are creating an Item/Variant link						
			Not Applicable	Less than 5 minutes	5-10 minutes	10-15 minutes	15-20 minutes	More than 20 minutes	Total
How much time do you spend in KOLA, weekly, in average?	0 to 4 hours	Count	1	6	7	5	5	2	26
		Expected Count	3.2	6.1	6.8	5.3	3.6	1.1	26.0
	4 to 20 hours	Count	2	5	7	4	2	1	21
		Expected Count	2.6	4.9	5.5	4.3	2.9	.9	21.0
	over 20 hours	Count	6	6	5	6	3	0	26
		Expected Count	3.2	6.1	6.8	5.3	3.6	1.1	26.0
Total		Count	9	17	19	15	10	3	73
		Expected Count	9.0	17.0	19.0	15.0	10.0	3.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.956[a]	10	.633
Likelihood Ratio	8.909	10	.541
N of Valid Cases	73		

a. 11 cells (61.1%) have expected count less than 5. The minimum expected count is .86.

Figure C.11: Regression analysis between amount of time it take to select variant combination while creating an Item/Variant link and average amount of time spent in KOLA weekly.

			How much time would it take to perform the following tasks, in average? _Select your variant combination while you are creating an Item/Variant link						
			Not Applicable	Less than 5 minutes	5-10 minutes	10-15 minutes	15-20 minutes	More than 20 minutes	Total
How long have you been working with KOLA?	Less than 8 years	Count	4	3	10	6	3	2	28
		Expected Count	3.5	6.5	7.3	5.8	3.8	1.2	28.0
	Over 8 year	Count	5	14	9	9	7	1	45
		Expected Count	5.5	10.5	11.7	9.2	6.2	1.8	45.0
Total		Count	9	17	19	15	10	3	73
		Expected Count	9.0	17.0	19.0	15.0	10.0	3.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.192[a]	5	.288
Likelihood Ratio	6.481	5	.262
N of Valid Cases	73		

a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 1.15.

Figure C.12: Regression analysis between amount of time it takes to select variant combination while creating an Item/Variant link and years of experience.

			How much time would it take to perform the following tasks, in average? _Check variant authorizations(product type) while you are creating an Item/Variant link						
			Not Applicable	Less than 5 minutes	5-10 minutes	10-15 minutes	15-20 minutes	More tha 20 minutes	Total
How much time do you spend in KOLA, weekly, in average?	0 to 4 hours	Count	2	4	6	6	6	2	26
		Expected Count	3.6	4.6	5.0	6.1	4.3	2.5	26.0
	4 to 20 hours	Count	2	4	4	4	3	4	21
		Expected Count	2.9	3.7	4.0	4.9	3.5	2.0	21.0
	over 20 hours	Count	6	5	4	7	3	1	26
		Expected Count	3.6	4.6	5.0	6.1	4.3	2.5	26.0
Total		Count	10	13	14	17	12	7	73
		Expected Count	10.0	13.0	14.0	17.0	12.0	7.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.553[a]	10	.672
Likelihood Ratio	7.236	10	.703
N of Valid Cases	73		

a. 16 cells (88.9%) have expected count less than 5. The minimum expected count is 2.01.

Figure C.13: Regression analysis between amount of time it take to check variant authorization while creating an Item/Variant link and average amount of time spent in KOLA weekly.

			How much time would it take to perform the following tasks, in average? _Check variant authorizations(product type) while you are creating an Item/Variant link						
			Not Applicable	Less than 5 minutes	5-10 minutes	10-15 minutes	15-20 minutes	More tha 20 minutes	Total
How long have you been working with KOLA?	Less than 8 years	Count	3	3	7	9	4	2	28
		Expected Count	3.8	5.0	5.4	6.5	4.6	2.7	28.0
	Over 8 year	Count	7	10	7	8	8	5	45
		Expected Count	6.2	8.0	8.6	10.5	7.4	4.3	45.0
Total		Count	10	13	14	17	12	7	73
		Expected Count	10.0	13.0	14.0	17.0	12.0	7.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.323[a]	5	.504
Likelihood Ratio	4.373	5	.497
N of Valid Cases	73		

a. 5 cells (41.7%) have expected count less than 5. The minimum expected count is 2.68.

Figure C.14: Regression analysis between amount of time it takes to check variant authorization while creating an Item/Variant link and years of experience.

			How much time would it take to perform the following tasks, in average? _Check variant restrictions while you are creating an Item/Variant link						
			Not Applicable	Less than 5 minutes	5-10 minutes	10-15 minutes	15-20 minutes	More than 20 minutes	Total
How much time do you spend in KOLA, weekly, in average?	0 to 4 hours	Count	1	3	7	5	8	2	26
		Expected Count	3.2	3.6	5.0	6.1	5.7	2.5	26.0
	4 to 20 hours	Count	2	4	4	5	3	3	21
		Expected Count	2.6	2.9	4.0	4.9	4.6	2.0	21.0
	over 20 hours	Count	6	3	3	7	5	2	26
		Expected Count	3.2	3.6	5.0	6.1	5.7	2.5	26.0
Total		Count	9	10	14	17	16	7	73
		Expected Count	9.0	10.0	14.0	17.0	16.0	7.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.893[a]	10	.542
Likelihood Ratio	8.903	10	.541
N of Valid Cases	73		

a. 14 cells (77.8%) have expected count less than 5. The minimum expected count is 2.01.

Figure C.15: Regression analysis between amount of time check variant restrictions while creating an Item/Variant link and average amount of time spent in KOLA weekly.

Count

		How much time would it take to perform the following tasks, in average? _Check variant restrictions while you are creating an Item/Variant link						
		Not Applicable	Less than 5 minutes	5-10 minutes	10-15 minutes	15-20 minutes	More than 20 minutes	Total
How long have you been working with KOLA?	Less than 8 years	3	1	8	9	5	2	28
	Over 8 year	6	9	6	8	11	5	45
Total		9	10	14	17	16	7	73

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.741[a]	5	.171
Likelihood Ratio	8.365	5	.137
Linear-by-Linear Association	.090	1	.764
N of Valid Cases	73		

a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is 2.68.

Figure C.16: Regression analysis between amount of time it takes to check variant restrictions while creating an Item/Variant link and years of experience.

Crosstab

			From 1 to 5, please rank the complexity of the following tasks?_Creating DCN						
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremely Complex	Total
How much time do you spend in KOLA, weekly, in average?	0 to 4 hours	Count	1	16	8	0	1	0	26
		Expected Count	.7	13.9	8.5	1.4	.7	.7	26.0
	4 to 20 hours	Count	0	10	8	2	0	1	21
		Expected Count	.6	11.2	6.9	1.2	.6	.6	21.0
	over 20 hours	Count	1	13	8	2	1	1	26
		Expected Count	.7	13.9	8.5	1.4	.7	.7	26.0
Total		Count	2	39	24	4	2	2	73
		Expected Count	2.0	39.0	24.0	4.0	2.0	2.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.795[a]	10	.832
Likelihood Ratio	8.804	10	.551
Linear-by-Linear Association	1.353	1	.245
N of Valid Cases	73		

a. 12 cells (66.7%) have expected count less than 5. The minimum expected count is .58.

Figure C.17: Regression analysis between level of complexity of creating DCN and average amount of time spent in KOLA weekly.

Crosstab

			From 1 to 5, please rank the complexity of the following tasks?_Creating DCN						
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremely Complex	Total
How long have you been working with KOLA?	Less than 8 years	Count	1	15	9	0	2	1	28
		Expected Count	.8	15.0	9.2	1.5	.8	.8	28.0
	Over 8 year	Count	1	24	15	4	0	1	45
		Expected Count	1.2	24.0	14.8	2.5	1.2	1.2	45.0
Total		Count	2	39	24	4	2	2	73
		Expected Count	2.0	39.0	24.0	4.0	2.0	2.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.940[a]	5	.312
Likelihood Ratio	7.934	5	.160
Linear-by-Linear Association	.080	1	.777
N of Valid Cases	73		

a. 8 cells (66.7%) have expected count less than 5. The minimum expected count is .77.

Figure C.18: Regression analysis between level of complexity of creating DCN and years of experience.

Crosstab

			From 1 to 5, please rank the complexity of the following tasks?_Creating DCN						
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremely Complex	Total
How much time would it take to perform the following tasks, in average? _Create DCN	Not Applicable	Count	2	1	1	0	0	0	4
		Expected Count	.1	2.1	1.3	.2	.1	.1	4.0
	Less than 5minutes	Count	0	24	9	1	0	0	34
		Expected Count	.9	18.2	11.2	1.9	.9	.9	34.0
	5-10 minutes	Count	0	5	5	0	0	0	10
		Expected Count	.3	5.3	3.3	.5	.3	.3	10.0
	10-15 minutes	Count	0	8	7	1	0	0	16
		Expected Count	.4	8.5	5.3	.9	.4	.4	16.0
	15-20 minutes	Count	0	1	1	1	1	0	4
		Expected Count	.1	2.1	1.3	.2	.1	.1	4.0
	More than 20 minutes	Count	0	0	1	1	1	2	5
		Expected Count	.1	2.7	1.6	.3	.1	.1	5.0
Total		Count	2	39	24	4	2	2	73
		Expected Count	2.0	39.0	24.0	4.0	2.0	2.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	90.123[a]	25	.000
Likelihood Ratio	46.197	25	.006
Linear-by-Linear Association	26.992	1	.000
N of Valid Cases	73		

a. 31 cells (86.1%) have expected count less than 5. The minimum expected count is .11.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.612[a]	.375	.366	.759

a. Predictors: (Constant), How much time would it take to perform the following tasks, in average? _Create DCN

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.741	.159		4.656	.000
	How much time would it take to perform the following tasks, in average? _Create DCN	.440	.067	.612	6.525	.000

a. Dependent Variable: From 1 to 5, please rank the complexity of the following tasks?_Creating DCN

Figure C.19: Regression analysis between level of complexity of creating DCN and the time takes to perform the task.

Crosstab

			From 1 to 5, please rank the complexity of the following tasks?_Creating and releasing an item						Total
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremely Complex	
How much time do you spend in KOLA, weekly, in average?	0 to 4 hours	Count	1	10	12	2	1	0	26
		Expected Count	1.1	7.8	11.0	3.6	1.8	.7	26.0
	4 to 20 hours	Count	1	6	9	3	2	0	21
		Expected Count	.9	6.3	8.9	2.9	1.4	.6	21.0
	over 20 hours	Count	1	6	10	5	2	2	26
		Expected Count	1.1	7.8	11.0	3.6	1.8	.7	26.0
Total		Count	3	22	31	10	5	2	73
		Expected Count	3.0	22.0	31.0	10.0	5.0	2.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.733[a]	10	.750
Likelihood Ratio	7.342	10	.693
Linear-by-Linear Association	3.802	1	.051
N of Valid Cases	73		

a. 12 cells (66.7%) have expected count less than 5. The minimum expected count is .58.

C.20: Regression analysis between level of complexity of creating and releasing an item and average amount of time spent in KOLA weekly.

Crosstab

			From 1 to 5, please rank the complexity of the following tasks?_Creating and releasing an item						
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremely Complex	Total
How long have you been working with KOLA?	Less than 8 years	Count	1	8	12	4	3	0	28
		Expected Count	1.2	8.4	11.9	3.8	1.9	.8	28.0
	Over 8 year	Count	2	14	19	6	2	2	45
		Expected Count	1.8	13.6	19.1	6.2	3.1	1.2	45.0
Total		Count	3	22	31	10	5	2	73
		Expected Count	3.0	22.0	31.0	10.0	5.0	2.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.317[a]	5	.804
Likelihood Ratio	2.973	5	.704
Linear-by-Linear Association	.030	1	.863
N of Valid Cases	73		

a. 7 cells (58.3%) have expected count less than 5. The minimum expected count is .77.

C.21: Regression analysis between level of complexity of creating and releasing an item and years of experience.

Crosstab

			From 1 to 5, please rank the complexity of the following tasks?_Creating and releasing an item						
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremely Complex	Total
How much time would it take to perform the following tasks, in average? _Create and release an item	Not Applicable	Count	3	1	0	1	1	0	6
		Expected Count	.2	1.8	2.5	.8	.4	.2	6.0
	Less than 5 minutes	Count	0	10	5	0	0	0	15
		Expected Count	.6	4.5	6.4	2.1	1.0	.4	15.0
	5-10 minutes	Count	0	4	4	3	0	0	11
		Expected Count	.5	3.3	4.7	1.5	.8	.3	11.0
	10-15 minutes	Count	0	6	14	4	0	0	24
		Expected Count	1.0	7.2	10.2	3.3	1.6	.7	24.0
	15-20 minutes	Count	0	0	4	0	2	0	6
		Expected Count	.2	1.8	2.5	.8	.4	.2	6.0
	More than minutes	Count	0	1	4	2	2	2	11
		Expected Count	.5	3.3	4.7	1.5	.8	.3	11.0
Total		Count	3	22	31	10	5	2	73
		Expected Count	3.0	22.0	31.0	10.0	5.0	2.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	78.025[a]	25	.000
Likelihood Ratio	60.952	25	.000
Linear-by-Linear Association	18.359	1	.000
N of Valid Cases	73		

a. 33 cells (91.7%) have expected count less than 5. The minimum expected count is .16.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.505[a]	.255	.244	.927

a. Predictors: (Constant), How much time would it take to perform the following tasks, in average? _Create and release an item

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.047	.217		4.830	.000
	How much time would it take to perform the following tasks, in average? _Create and release an item	.359	.073	.505	4.929	.000

a. Dependent Variable: From 1 to 5, please rank the complexity of the following tasks?_Creating and releasing an item

C.22: Regression analysis between level of complexity of creating and releasing an item and the time takes to perform the task.

Crosstab

			From 1 to 5, please rank the complexity of the following tasks?_Creating Item/Variant link						Total
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremely Complex	
How much time do you spend in KOLA, weekly, in average?	0 to 4 hours	Count	1	6	10	7	2	0	26
		Expected Count	2.5	6.1	7.8	5.7	3.2	.7	26.0
	4 to 20 hours	Count	1	6	9	0	3	2	21
		Expected Count	2.0	4.9	6.3	4.6	2.6	.6	21.0
	over 20 hours	Count	5	5	3	9	4	0	26
		Expected Count	2.5	6.1	7.8	5.7	3.2	.7	26.0
Total		Count	7	17	22	16	9	2	73
		Expected Count	7.0	17.0	22.0	16.0	9.0	2.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	21.551[a]	10	.018
Likelihood Ratio	26.476	10	.003
Linear-by-Linear Association	.012	1	.912
N of Valid Cases	73		

a. 11 cells (61.1%) have expected count less than 5. The minimum expected count is .58.

C.23: Regression analysis between level of complexity of creating Item/Variant link and average amount of time spent in KOLA weekly.

Crosstab

			From 1 to 5, please rank the complexity of the following tasks?_Creating Item/Variant link						
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremely Complex	Total
How long have you been working with KOLA?	Less than 8 years	Count	4	4	10	5	4	1	28
		Expected Count	2.7	6.5	8.4	6.1	3.5	.8	28.0
	Over 8 year	Count	3	13	12	11	5	1	45
		Expected Count	4.3	10.5	13.6	9.9	5.5	1.2	45.0
Total		Count	7	17	22	16	9	2	73
		Expected Count	7.0	17.0	22.0	16.0	9.0	2.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.692[a]	5	.595
Likelihood Ratio	3.764	5	.584
Linear-by-Linear Association	.011	1	.916
N of Valid Cases	73		

a. 5 cells (41.7%) have expected count less than 5. The minimum expected count is .77.

C.24: Regression analysis between level of complexity of creating Item/Variant link and years of experience.

Crosstab

			From 1 to 5, please rank the complexity of the following tasks?_Creating Item/Variant link						
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremely Complex	Total
How much time would it take to perform the following tasks, in average? _Create Item/Variant link	Not Applicable	Count	7	0	0	1	0	0	8
		Expected Count	.8	1.9	2.4	1.8	1.0	.2	8.0
	More than 5 minutes	Count	0	11	10	2	1	0	24
		Expected Count	2.3	5.6	7.2	5.3	3.0	.7	24.0
	5-10 minutes	Count	0	4	1	1	3	0	9
		Expected Count	.9	2.1	2.7	2.0	1.1	.2	9.0
	10-15 minutes	Count	0	1	10	7	2	0	20
		Expected Count	1.9	4.7	6.0	4.4	2.5	.5	20.0
	15-20 minutes	Count	0	1	1	2	3	1	8
		Expected Count	.8	1.9	2.4	1.8	1.0	.2	8.0
	More than 20 minutes	Count	0	0	0	3	0	1	4
		Expected Count	.4	.9	1.2	.9	.5	.1	4.0
Total		Count	7	17	22	16	9	2	73
		Expected Count	7.0	17.0	22.0	16.0	9.0	2.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	110.557[a]	25	.000
Likelihood Ratio	84.751	25	.000
Linear-by-Linear Association	28.279	1	.000
N of Valid Cases	73		

a. 32 cells (88.9%) have expected count less than 5. The minimum expected count is .11.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.627[a]	.393	.384	.987

a. Predictors: (Constant), How much time would it take to perform the following tasks, in average? _Create Item/Variant link

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.944	.209		4.519	.000
	How much time would it take to perform the following tasks, in average? _Create Item/Variant link	.559	.082	.627	6.777	.000

a. Dependent Variable: From 1 to 5, please rank the complexity of the following tasks?_Creating Item/Variant link

C.25: Regression analysis between level of complexity of creating Item/Variant link and the time takes to perform the task.

Crosstab

			From 1 to 5, please rank the complexity of the following tasks?_Selecting your variant combination while you are creating an Item/Variant link						
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremel Complex	Total
How much time do you spend in KOLA, weekly, in average?	0 to 4 hours	Count	1	2	10	8	4	1	26
		Expected Count	2.8	2.5	8.2	6.1	5.0	1.4	26.0
	4 to 20 hours	Count	2	3	9	3	2	2	21
		Expected Count	2.3	2.0	6.6	4.9	4.0	1.2	21.0
	over 20 hours	Count	5	2	4	6	8	1	26
		Expected Count	2.8	2.5	8.2	6.1	5.0	1.4	26.0
Total		Count	8	7	23	17	14	4	73
		Expected Count	8.0	7.0	23.0	17.0	14.0	4.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.217[a]	10	.271
Likelihood Ratio	12.602	10	.247
Linear-by-Linear Association	.042	1	.838
N of Valid Cases	73		

a. 13 cells (72.2%) have expected count less than 5. The minimum expected count is 1.15.

Figure C.26: Regression analysis between level of complexity of selecting variant combination while creating Item/Variant link and average amount of time spent in KOLA per week.

Crosstab

			From 1 to 5, please rank the complexity of the following tasks?_Selecting your variant combination while you are creating an Item/Variant link						
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremel Complex	Total
How long have you been working with KOLA?	Less than 8 years	Count	4	2	11	4	6	1	28
		Expected Count	3.1	2.7	8.8	6.5	5.4	1.5	28.0
	Over 8 year	Count	4	5	12	13	8	3	45
		Expected Count	4.9	4.3	14.2	10.5	8.6	2.5	45.0
Total		Count	8	7	23	17	14	4	73
		Expected Count	8.0	7.0	23.0	17.0	14.0	4.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.617[a]	5	.606
Likelihood Ratio	3.726	5	.589
Linear-by-Linear Association	.515	1	.473
N of Valid Cases	73		

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is 1.53.

Figure C.27: Regression analysis between level of complexity of selecting variant combination while creating Item/Variant link and years of experience.

			From 1 to 5, please rank the complexity of the following tasks?_Selecting your variant combination while you are creating an Item/Variant link						
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremel Complex	Total
How much time would it take to perform the following tasks, in average? _Select your variant combination while you are creating an Item/Variant link	Not Applicable	Count	8	0	0	1	0	0	9
		Expected Count	1.0	.9	2.8	2.1	1.7	.5	9.0
	Less than 5 minutes	Count	0	6	7	2	2	0	17
		Expected Count	1.9	1.6	5.4	4.0	3.3	.9	17.0
	5-10 minutes	Count	0	0	10	5	4	0	19
		Expected Count	2.1	1.8	6.0	4.4	3.6	1.0	19.0
	10-15 minutes	Count	0	0	4	7	4	0	15
		Expected Count	1.6	1.4	4.7	3.5	2.9	.8	15.0
	15-20 minutes	Count	0	1	2	2	3	2	10
		Expected Count	1.1	1.0	3.2	2.3	1.9	.5	10.0
	More than 20 minutes	Count	0	0	0	0	1	2	3
		Expected Count	.3	.3	.9	.7	.6	.2	3.0
Total		Count	8	7	23	17	14	4	73
		Expected Count	8.0	7.0	23.0	17.0	14.0	4.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	117.651[a]	25	.000
Likelihood Ratio	86.596	25	.000
Linear-by-Linear Association	33.552	1	.000
N of Valid Cases	73		

a. 34 cells (94.4%) have expected count less than 5. The minimum expected count is .16.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.683[a]	.466	.458	.997

a. Predictors: (Constant), How much time would it take to perform the following tasks, in average? _Select your variant combination while you are creating an Item/Variant link

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	1.026	.217		4.727	.000
	How much time would it take to perform the following tasks, in average? _Select your variant combination while you are creating an Item/Variant link	.678	.086	.683	7.871	.000

a. Dependent Variable: From 1 to 5, please rank the complexity of the following tasks?_Selecting your variant combination while you are creating an Item/Variant link

Figure C.28: Regression analysis between level of complexity of selecting variant combination while creating Item/Variant link and the time takes to perform the task.

Crosstab

			From 1 to 5, please rank the complexity of the following tasks?_Checking variant authorizations (product type) while you are creating an Item/Variant link						
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremely Complex	Total
How much time do you spend in KOLA, weekly, in average?	0 to 4 hours	Count	1	1	4	10	7	3	26
		Expected Count	2.5	1.4	3.6	9.3	5.7	3.6	26.0
	4 to 20 hours	Count	2	2	3	9	2	3	21
		Expected Count	2.0	1.2	2.9	7.5	4.6	2.9	21.0
	over 20 hours	Count	4	1	3	7	7	4	26
		Expected Count	2.5	1.4	3.6	9.3	5.7	3.6	26.0
Total		Count	7	4	10	26	16	10	73
		Expected Count	7.0	4.0	10.0	26.0	16.0	10.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.967[a]	10	.818
Likelihood Ratio	6.400	10	.781
Linear-by-Linear Association	.344	1	.557
N of Valid Cases	73		

a. 13 cells (72.2%) have expected count less than 5. The minimum expected count is 1.15.

Figure C.29: Regression analysis between level of complexity of checking variant authorizations while creating an Item/Variant link and average amount of time spent in KOLA per week.

Crosstab

			From 1 to 5, please rank the complexity of the following tasks?_Checking variant authorizations (product type) while you are creating an Item/Variant link						
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremely Complex	Total
How long have you been working with KOLA?	Less than 8 years	Count	3	0	4	11	4	6	28
		Expected Count	2.7	1.5	3.8	10.0	6.1	3.8	28.0
	Over 8 year	Count	4	4	6	15	12	4	45
		Expected Count	4.3	2.5	6.2	16.0	9.9	6.2	45.0
Total		Count	7	4	10	26	16	10	73
		Expected Count	7.0	4.0	10.0	26.0	16.0	10.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.920[a]	5	.314
Likelihood Ratio	7.302	5	.199
Linear-by-Linear Association	.496	1	.481
N of Valid Cases	73		

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is 1.53.

Figure C.30: Regression analysis between level of complexity of checking variant authorizations while creating an Item/Variant link and years of experience.

			From 1 to 5, please rank the complexity of the following tasks?_Checking variant authorizations (product type) while you are creating an Item/Variant link						
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremely Complex	Total
How much time would it take to perform the following tasks, in average? _Check variant authorizations (product type) while you are creating an Item/Variant link	Not Applicable	Count	7	0	0	2	1	0	10
		Expected Count	1.0	.5	1.4	3.6	2.2	1.4	10.0
	Less than 5 minutes	Count	0	4	6	2	0	1	13
		Expected Count	1.2	.7	1.8	4.6	2.8	1.8	13.0
	5-10 minutes	Count	0	0	2	8	4	0	14
		Expected Count	1.3	.8	1.9	5.0	3.1	1.9	14.0
	10-15 minutes	Count	0	0	2	8	4	3	17
		Expected Count	1.6	.9	2.3	6.1	3.7	2.3	17.0
	15-20 minutes	Count	0	0	0	5	6	1	12
		Expected Count	1.2	.7	1.6	4.3	2.6	1.6	12.0
	More tha 20 minutes	Count	0	0	0	1	1	5	7
		Expected Count	.7	.4	1.0	2.5	1.5	1.0	7.0
Total		Count	7	4	10	26	16	10	73
		Expected Count	7.0	4.0	10.0	26.0	16.0	10.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	111.633[a]	25	.000
Likelihood Ratio	87.912	25	.000
Linear-by-Linear Association	35.605	1	.000
N of Valid Cases	73		

a. 35 cells (97.2%) have expected count less than 5. The minimum expected count is .38.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.703[a]	.495	.487	1.016

a. Predictors: (Constant), How much time would it take to perform the following tasks, in average? _Check variant authorizations(product type) while you are creating an Item/Variant link

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	1.400	.222		6.319	.000
	How much time would it take to perform the following tasks, in average? _Check variant authorizations (product type) while you are creating an Item/Variant link	.650	.078	.703	8.334	.000

a. Dependent Variable: From 1 to 5, please rank the complexity of the following tasks?_Checking variant authorizations(product type) while you are creating an Item/Variant link

Figure C.31: Regression analysis between level of complexity of checking variant authorizations while selecting variant combination while creating Item/Variant link and the time takes to perform the task.

Count

		From 1 to 5, please rank the complexity of the following tasks?_Checking variant restrictions while you are creating an Item/Variant link						
		Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremely Complex	Total
How much time do you spend in KOLA, weekly, in average?	0 to 4 hours	1	1	5	6	9	4	26
	4 to 20 hours	2	2	4	6	3	4	21
	over 20 hours	4	1	3	8	6	4	26
Total		7	4	12	20	18	12	73

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.681[a]	10	.841
Likelihood Ratio	5.803	10	.832
Linear-by-Linear Association	.882	1	.348
N of Valid Cases	73		

a. 12 cells (66.7%) have expected count less than 5. The minimum expected count is 1.15.

Figure C.32: Regression analysis between level of complexity of checking variant restrictions while creating an Item/Variant link and average amount of time spent in KOLA weekly.

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Crosstab

			From 1 to 5, please rank the complexity of the following tasks?_Checking variant restrictions while you are creating an Item/Variant link						
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremely Complex	Total
How long have you been working with KOLA?	Less than 8 years	Count	3	0	3	10	6	6	28
		Expected Count	2.7	1.5	4.6	7.7	6.9	4.6	28.0
	Over 8 year	Count	4	4	9	10	12	6	45
		Expected Count	4.3	2.5	7.4	12.3	11.1	7.4	45.0
Total		Count	7	4	12	20	18	12	73
		Expected Count	7.0	4.0	12.0	20.0	18.0	12.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.481[a]	5	.360
Likelihood Ratio	6.871	5	.230
Linear-by-Linear Association	.838	1	.360
N of Valid Cases	73		

a. 6 cells (50.0%) have expected count less than 5. The minimum expected count is 1.53.

C.33: Regression analysis between level of complexity of checking variant restrictions while creating an Item/Variant link and level of experience.

			From 1 to 5, please rank the complexity of the following tasks?_Checking variant restrictions while you are creating an Item/Variant link						
			Not Applicable	Not Complex	Slightly Complex	Complex	Very Complex	Extremely Complex	Total
How much time would it take to perform the following tasks, in average? _Check variant restrictions while you are creating an Item/Variant link	Not Applicable	Count	7	0	0	1	1	0	9
		Expected Count	.9	.5	1.5	2.5	2.2	1.5	9.0
	Less than 5 minutes	Count	0	4	5	1	0	0	10
		Expected Count	1.0	.5	1.6	2.7	2.5	1.6	10.0
	5-10 minutes	Count	0	0	3	8	3	0	14
		Expected Count	1.3	.8	2.3	3.8	3.5	2.3	14.0
	10-15 minutes	Count	0	0	2	5	5	5	17
		Expected Count	1.6	.9	2.8	4.7	4.2	2.8	17.0
	15-20 minutes	Count	0	0	2	5	8	1	16
		Expected Count	1.5	.9	2.6	4.4	3.9	2.6	16.0
	More than 20 minutes	Count	0	0	0	0	1	6	7
		Expected Count	.7	.4	1.2	1.9	1.7	1.2	7.0
Total		Count	7	4	12	20	18	12	73
		Expected Count	7.0	4.0	12.0	20.0	18.0	12.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	130.011[a]	25	.000
Likelihood Ratio	98.702	25	.000
Linear-by-Linear Association	40.107	1	.000
N of Valid Cases	73		

a. 36 cells (100.0%) have expected count less than 5. The minimum expected count is .38.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.746[a]	.557	.551	.990

a. Predictors: (Constant), How much time would it take to perform the following tasks, in average?

_Check variant restrictions while you are creating an Item/Variant link

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	1.144	.229		4.987	.000
	How much time would it take to perform the following tasks, in average? _Check variant restrictions while you are creating an Item/Variant link	.726	.077	.746	9.449	.000

a. Dependent Variable: From 1 to 5, please rank the complexity of the following tasks?_Checking variant restrictions while you are creating an Item/Variant link

C.34: Regression analysis between level of complexity of checking variant restrictions while creating an Item/Variant link and the time takes to perform the task.

Crosstab

			How useful do you think it is, if the system could guide users step by step through the process of creating Item/Variant link? (with the possibility of deactivating) Extremely useful	very useful	Useful	Total
How much time do you spend in KOLA, weekly, in average?	0 to 4 hours	Count	9	8	9	26
		Expected Count	6.1	11.4	8.5	26.0
	4 to 20 hours	Count	3	13	5	21
		Expected Count	4.9	9.2	6.9	21.0
	over 20 hours	Count	5	11	10	26
		Expected Count	6.1	11.4	8.5	26.0
Total		Count	17	32	24	73
		Expected Count	17.0	32.0	24.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.733[a]	4	.220
Likelihood Ratio	5.658	4	.226
Linear-by-Linear Association	.858	1	.354
N of Valid Cases	73		

a. 1 cells (11.1%) have expected count less than 5. The minimum expected count is 4.89.

Figure C.35: Regression analysis between step by step guidance while creating Item/variant link and average amount of time spent in KOLA weekly.

Crosstab

			How useful do you think it is, if the system could guide users step by step through the process of creating Item/Variant link? (with the possibility of deactivating)			Total
			Extremely useful	very useful	Useful	
How long have you been working with KOLA?	Less than 8 years	Count	8	16	4	28
		Expected Count	6.5	12.3	9.2	28.0
	Over 8 year	Count	9	16	20	45
		Expected Count	10.5	19.7	14.8	45.0
Total		Count	17	32	24	73
		Expected Count	17.0	32.0	24.0	73.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.155[a]	2	.028
Likelihood Ratio	7.707	2	.021
Linear-by-Linear Association	4.622	1	.032
N of Valid Cases	73		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.52.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.253[a]	.064	.051	.729

a. Predictors: (Constant), How long have you been working with KOLA?

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.470	.296		4.962	.000
	How long have you been working with KOLA?	.387	.175	.253	2.207	.031

a. Dependent Variable: How useful do you think it is, if the system could guide users step by step through the process of creating Item/Variant link? (with the possibility of deactivating)

Figure C.36: Regression analysis between step by step guidance while creating Item/variant link and years of experience.