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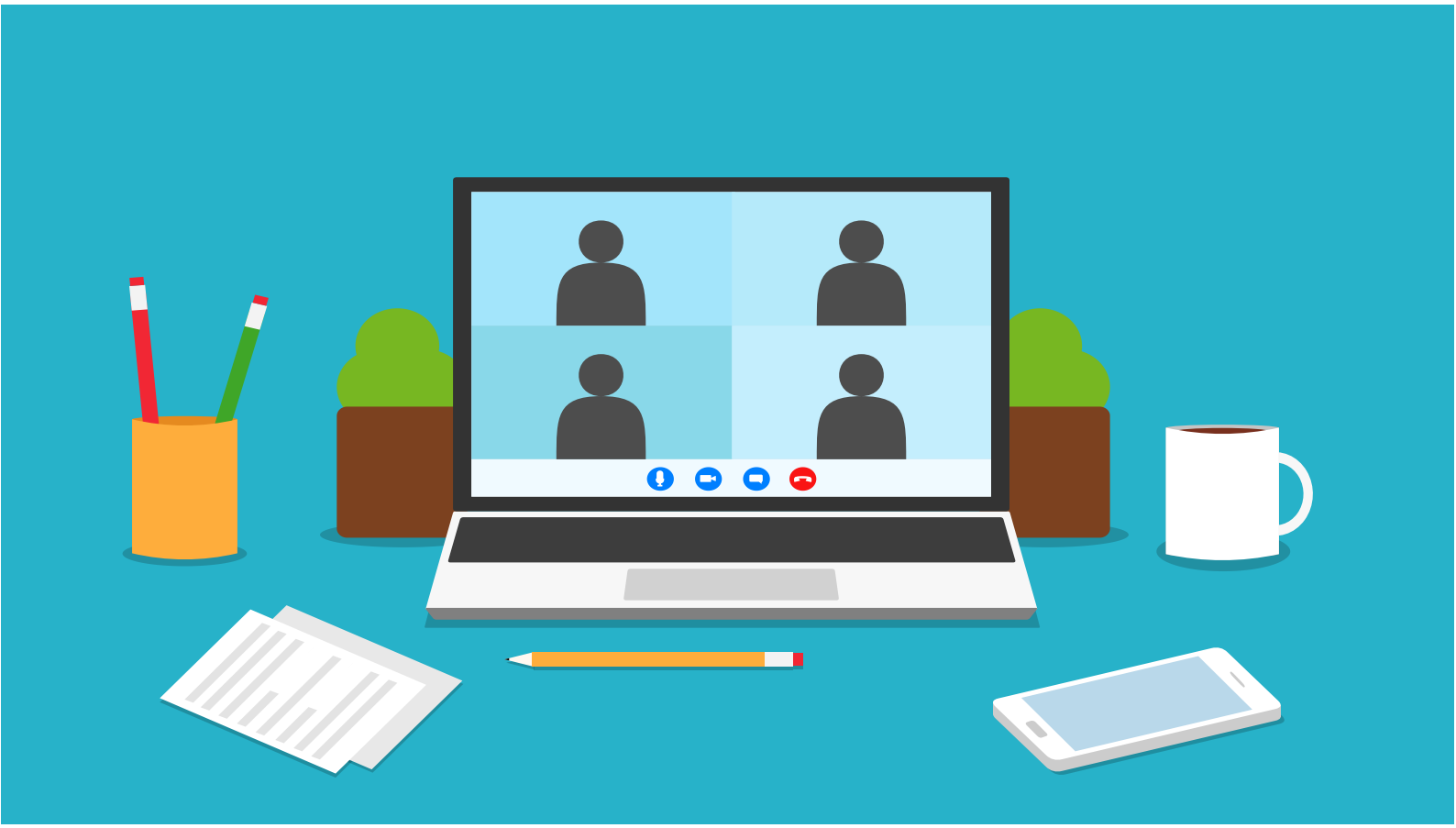

# Remote Requirements Elicitation

## Considerations for Developers Gathered From Practice Studies and Existing Literature

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Master Thesis

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**Abstract:**

The topic remote requirements elicitation was investigated through three different studies: literature review, case study and experiment. The literature review has investigated the research topics and approach in existing literature. Three topics were found in the literature: successes and challenges, forms of communication, and techniques. Five types of study have been used in the literature: literature review, survey, case study, experiment, and the defining of a model or tool. The case study has investigated the successes and challenges when adapting requirements elicitation techniques to a remote environment. Four elicitation techniques were investigated: interviews, prototyping, think aloud, and scenarios. The results showed five areas of success and six areas of challenges. The experiment has compared different types of visual presentation and communication forms when writing user stories in a remote environment. The visual presentation forms were video, photos and being shown no visual presentation, while the communication forms were online meeting and instant messaging. The results showed, that video presentation together with online meeting yielded higher quality user stories and increased communication. Together the three articles provides considerations for developers from existing literature and practice studies. This entails insight on how remote requirements elicitation can be used and the impacting successes and challenges.

# Preface

This report presents the master thesis project written by the group cs-23-sd-10-01 from Aalborg University. The master thesis incorporates findings presented in a previous report written by the authors [1]. The whole master thesis project has been conducted in the second half of 2022 and the first half of 2023.

The report consists of 4 chapters that present three articles, that are available in the appendix. Chapter 1 is an introduction to the overall problem statement along with the research questions for each article. Chapter 2 describes the contributions from the three articles. Chapter 3 describes the research methods used throughout the work in the three articles. Chapter 4 is a recapitulation of the report which includes conclusion, limitations, and future work.

We would like to thank our project supervisor, Jan Stage, for guidance and constructive feedback throughout the master thesis project.

We would like to thank the company from the case study presented in the second article for its collaboration throughout this project.

We would like to thank the participants in the experiment presented in the third article for their willingness to be a part of this project. We also thank the company that provided knowledge to the case used in the experiment.

# Summary

This report explores remote requirements elicitation by investigating the considerations that can be found through practice and existing literature. This is covered by three articles, that is summarized in this report. The full version of the articles can be found in the appendix.

The first article reports from a literature review that examined topics that have been investigated and which types of studies that have been performed in remote requirements elicitation. This gives basic knowledge of what can be found in the remote requirements elicitation field. The literature review was performed using a fully described search process. The initial search resulted in 319 papers, but through this process these were cut down to 31 papers that were relevant and inside the scope of the review. Three main topics were found through the literature review: successes and challenges, forms of communication, and techniques. Furthermore, five types of study were found: literature review, surveys, case study, experiment and defining a model or tool. The results have shown that the number of papers are limited in the last five years.

The second article reports from a case study that investigated the successes and challenges developers have to consider when adapting requirements elicitation techniques to a remote environment between customer and developers. This study gives an understanding of the practices that can be utilized in remote requirements elicitation. The case study was conducted through a 15 week collaboration with a company acting as customers, and the authors acted as developers. Four requirements elicitation techniques were utilized during the case study: interviews, prototyping, think aloud, and scenarios. This resulted in five areas of success concerning the selection of the right techniques, sending things beforehand, having observers, using design alternatives, and the setups used for the adaptation of the techniques. Six areas of challenges were also found concerning technical aspects, comfortability, and propositions for the usage of an observation technique.

The third article reports from an experiment that investigated the effect of using different types of visual presentations and communication forms, when writing user stories in collaboration with a customer in a remote environment. This experiment explores the effect that different conditions have when developers do remote requirements elicitation in practice. There were 18 participants that acted as developers in the experiment, and one of the authors acted as the customer and presented a case. The different types of visual presentation that was used was: video, photo, and none. There were two types of communication forms: online meeting and instant messaging. Through the experiment it was found that utilizing video presentation together with an online meeting produced the best quality of user stories and increased communication with the customer.

In conclusion the three articles present considerations for developers when using remote requirements elicitation through existing literature and practice. The considerations offer an understanding of how remote requirements elicitation can be used and which successes and challenges that have an impact.

# Contents

# 1. Introduction

This chapter gives an introduction to remote requirements elicitation. This is followed by a presentation of the problem statement and the research questions. In the end, there is a description of the research process used throughout the master thesis.

## 1.1 Research Field

Remote work has become more commonplace in recent years. This has been accelerated by the COVID-19 pandemic, which has forced developers to work from home. The shift to a remote environment has highlighted the benefits of remote work as a long-term solution for many software companies [2]. This is also reflected in the yearly surveys done by Stack Overflow, where 12% of developers said they worked fully remote in 2019, and in 2022 this has increased to 43% [3]. It should be noted that this number can be affected by countries, which were not over the pandemic in 2022.

The new working constellation also has an impact on requirements elicitation [4], which is the process of gathering information about the needs of the customers. This information is then used when specifying functional and non-functional requirements for a software system. Functional requirements describe the features within the software system, such as specific actions or tasks that should be available. In contrast non-functional requirements describe the quality attributes, which includes performance, security, usability, and reliability. Requirements elicitation is an important part of the software development cycle, as it helps ensure that the final software product provides value to end-users and meets the expectations of the customers.

Shifting requirements elicitation to a remote environment, involves adaptation of existing elicitation techniques such as interviews, prototyping, and focus groups. This adaptation is done through the usage of technologies that allow developers to communicate with customers in a remote environment. Software platforms such as Microsoft Teams or Zoom are widely used for this purpose [5], as they include technologies such as online meetings, instant messaging, online questionnaires, and drawing boards.

## 1.2 Problem Statement & Research Questions

This master thesis investigates the considerations developers have to make when shifting requirements elicitation to a remote environment, where a developer is geographically separated from a customer, leading to the following problem statement:

> **Problem statement:** What are the considerations developers have to make when using requirements elicitation in a remote environment?

Considerations entail offering insights on how to navigate the remote requirements elicitation field, by providing an understanding of how it can be used and the impacting successes and challenges. In order to cover these aspects the problem statement has been divided into the three research questions presented below:

> **Research question 1:** In remote requirements elicitation between customers and developers, what type of research has been conducted, and which topics have been investigated?

The first research question focuses on obtaining knowledge about the considerations in remote requirements elicitation from existing academic literature.

> **Research question 2:** What are the successes and challenges developers have to consider when utilizing requirements elicitation techniques adapted to a remote environment?

The second research question focuses on an investigation of using remote requirements elicitation together with a company that needs a software solution. The aim of this investigation is to present the considerations obtained from a practical perspective.

> **Research question 3:** What is the effect of using different types of visual presentations and communication forms, when writing user stories in a remote environment?

The third research question focuses on investigating alternative ways to gather information about the customers' needs in a remote environment. This is done by exploring alternatives to the observation requirements elicitation technique, because a developer cannot meet in-person with the customer in a remote environment. The aim of this investigation is to build upon the considerations from a practical perspective.

To answer both the problem statement and the research questions above, three articles have been written in this master thesis, one for each research question.

## 1.3 Research Process

The master thesis project stretched across two semesters. In the first semester information was gathered for the first research question through a literature review. This was done along with gathering information for the second research question through a case study done together with a Danish company that needed a software solution. The company acted as customers and the authors acted as developers.

In the second semester the findings gathered from the first semester have been further analyzed. Additionally, an experiment was done together with students within the software development field in order to gather information for the third research question.

# 2. Contributions

In this chapter, three research articles are presented, which is the main part of the master thesis project. Each article can be found in the appendix.

## 2.1 Overview

Below is a listing of the three articles, that are the research contribution of this master thesis project:

**Article 1**

Jakob Precht, Liv Holm, and Mai-Britt L. Laursen. Literature Review on Remote Requirements Elicitation, Department of Computer Science, Aalborg University, (2023).

**Article 2**

Jakob Precht, Liv Holm, and Mai-Britt L. Laursen. Successes and Challenges when Utilizing Requirements Elicitation Techniques Adapted to a Remote Environment, Department of Computer Science, Aalborg University, (2023).

**Article 3**

Jakob Precht, Liv Holm, and Mai-Britt L. Laursen. Remote Requirements Elicitation: Writing User Stories in Collaboration with a Customer, Department of Computer Science, Aalborg University, (2023).

The common ground for the three articles is considerations in remote requirements elicitation, and their relations are represented in a two by two matrix in Table 2.1. The rows represent the source of knowledge. 'Existing literature' represents academic literature in regards to remote requirements elicitation. 'Practice studies' represents the investigation of using remote requirements elicitation in practice. The first column 'Understanding' represents the gathering of knowledge in order to understand the research field. The second column 'Alternatives' represents the exploration of alternative ways to do remote requirements elicitation.

| | **Understanding** | **Alternatives** |
|---|---|---|
| **Existing literature** | Article 1 | |
| **Practice studies** | Article 2 | Article 3 |

**Table 2.1:** Relations between the contributions.

## 2.2 Article 1

Article 1

Jakob Precht, Liv Holm, and Mai-Britt L. Laursen. Literature Review on Remote Requirements Elicitation, Department of Computer Science, Aalborg University, (2023).

This contribution presents a literature review of papers about remote requirements elicitation between customers and developers. The papers are analyzed to find the topics investigated and types of study in the literature about remote requirements elicitation.

The literature review was structured with the framework defined by vom Brocke et al. [6]. The papers for the literature review were found using the Scopus database. The process of finding and analyzing the papers were conducted in four phases. In the first phase the scope of the review was defined. In phase two the topic of remote requirements elicitation was conceptualized by exploring the topic. In phase three the literature search was performed, this phase was divided into three steps. The initial literature search in the Scopus database gave 319 papers, which after the three steps were cut down to 31 papers.

From the analysis of the 31 papers, three topics has been found: successes and challenges, forms of communication, and techniques. The successes and challenges that were found in the literature were about collaboration, knowledge management, and culture and language.

The forms of communication that were found can be separated into two areas. The first area, synchronous communication covered topics such as video conferencing and audio. The second area, asynchronous communication covered wikis and text-based communication.

There was found four different techniques that could be used for remote requirements elicitation: wikis, requirements reuse, automated requirements elicitation, and use cases and scenarios. Furthermore, comparisons of elicitation techniques and how to choose an elicitation technique for remote requirements elicitation were found.

The papers have used five different types of study, which included literature review, survey, case study, experiment, and the definition of model/tool. Here, less than half of these papers had utilized an experimental approach in either a natural or artificial setting.

The number of papers published in the last five years were limited, which means the knowledge about the possibilities of newer technologies such as Teams or Zoom is limited.

## 2.3 Article 2

Article 2

Jakob Precht, Liv Holm, and Mai-Britt L. Laursen. Successes and Challenges when Utilizing Requirements Elicitation Techniques Adapted to a Remote Environment, Department of Computer Science, Aalborg University, (2023).

This second article presents a case study that have investigated the successes and challenges developers have to consider when adapting requirements elicitation techniques to a remote environment, where customers and developers are geographically separated. The study has been conducted through a 15 week collaboration with a company that provides service of cranes. The focus of this study contains two aspects: adaption to a remote environment and successes and challenges. The existing literature in these areas is limited, giving further sentiment to acquire additional knowledge within this topic.

Throughout the study, four requirements elicitation techniques were adapted to the remote environment. These techniques included interviews, prototyping, think aloud, and scenarios. Autoethnography was used to capture the perspective from the authors [7], that acted as developers. Here, the authors wrote entries after each meeting with the customers in order to reflect upon the used elicitation techniques. The customers' perspective was captured through Customer Feedback (CF) sessions, that was held as semi-structured interviews, at the end of each meeting with the customers.

The customers were both office and field workers, which helped capture different interest about the developed software solution. They had a varied experience with online meetings before, ranging from multiple years to having their first online meeting in this collaboration.

Five areas of successes was found throughout the collaboration. Three of these were not exclusive to the remote environment, but are still important considerations in the requirements elicitation activity. These three included the selection of the right techniques, sending things before a meeting in order to prepare the customer, and using design alternatives. The other two concerns no impact from observers in an online meeting and that the setups used for the adaptation of the techniques were familiar for the customers, making the whole process easier.

Six areas of challenges were also found. These included the usage of an online platform such as Teams, risk for technical problems, encountered security restrictions, smaller texts in prototypes, a need for observation in order to clarify information gathered from the customers, and awareness about comfortability.

## 2.4 Article 3

Article 3

Jakob Precht, Liv Holm, and Mai-Britt L. Laursen. Remote Requirements Elicitation: Writing User Stories in Collaboration with a Customer, Department of Computer Science, Aalborg University, (2023).

The third article presents an experiment that investigated the effect of using different types of visual presentation and communication form, when writing user stories in collaboration with a customer in a remote environment. The two variables being studied through this experiment are visual presentations of customer's needs and different types of communication forms that developers and customers can use to interact. The visual presentations conditions that were compared in the experiment are video, photos and showing no visuals. The types of communication conditions that were compared in the experiment are text-based communication through instant messaging and verbal communication through online meetings.

The experiment procedure consisted of 5 steps. In step (1) the experimenter gave an introduction to the participant. In step (2) the participant watched a recording of the customer presenting the case with the assigned type of visual corresponding to their condition. Step (3) consisted of an explanation on how the participant should write user stories as well as what they could do during the next step. In step (4) the participant wrote the user stories, while communicating with the customer though the assigned type of communication for their condition. In step (5) the participant received and filled out a questionnaire regarding the experience of the assigned types of visual and communication.

The user stories produced by the participants were evaluated using a modified version of the INVEST grid [8]. The letters in INVEST stands for independent, negotiable, valuable, estimable, small, and testable. Using the INVEST grid, the authors would score each user stories on the 6 letters with a score ranging from 0 to 3, where 3 is the best.

The expected results of the experiment were that the quality of the user stories created while using the visual presentation forms video and photo were higher compared to none. The results also showed that there was an increase in communication when participants talked through online meetings compared to text-based communication.

The unexpected results from the experiment was that the quality was higher when presenting the case through video compared to photo. Additionally, The answers from the questionnaire showed that there was no preference for the different visual presentation types or the different types of communication forms.

# 3. Research Methods

This chapter presents the research methods used in this master thesis project. First, an overview of the research method is depicted, followed by a discussion of the research method used in the papers.

## 3.1 Overview

The overview of the research methods used in the three articles are shown in Table 3.1.

| Research question | Research method | Research setting |
|---|---|---|
| 1 | Literature review | |
| 2 | Case study | Semi-natural setting |
| 3 | Experiment | Artificial setting |

**Table 3.1:** Overview of the research methods used in the three articles.

The research methods used in the three articles are based on research settings, which are either artificial, natural, or environment independent [9]. Below there are discussions of the methods used to investigate each of the research questions.

## 3.2 Article 1

The first research question was answered through a systematic literature review based on a framework by vom Brocke et al. [6]. This framework gives a systematic structure to the process. The strength of a systematic literature review is the systematic approach of how data is collected and analyzed. This ensures that the subject of interest is thoroughly investigated. The weakness of a literature review depends on validity and reliability.

The validity of a literature review relies on the accuracy of the data collection [6]. The accuracy is influenced by the choice of databases, journals, search string, and whether forward and backward search are applied. Furthermore, not knowing if the data collection is exhaustive is a weakness of the literature review. The accuracy of this literature review is influenced by the choice of using one search engine accompanied by no forward or backwards search, which means that the findings are not ensured to be exhaustive and might be broadened further. However, the search engine used is the largest single abstract and indexing database [10].

The reliability of a literature review depends on how detailed the literature search has been

described and if it can be replicated [6]. To ensure the reliability, the searching process for this literature review has been fully described, along with the inclusion and exclusion criteria. This ensures transparency in this literature review and allows other researchers to replicate and build upon the findings.

## 3.3 Article 2

The second research question was answered through a case study done together with a Danish company that provides service of cranes. The advantages of using a case study is that changes and processes over time can be analyzed [11]. Additionally, the collected data is grounded in a natural setting, which results in a rich and complicated analysis, as the results can be contradicting [9]. This study has been classified as using a semi-natural research setting. The reason for adding the term 'semi' in front of 'natural' was that the authors acted as developers without being part of a work process within a software company. However, an advantage of this approach is the freedom the authors had when setting up the research environment.

The disadvantage of case study is that it is difficult to generalize the findings [9]. This has not been minimized through the methods used in the case study. However, the case study can be build upon by conducting similar case studies to validate the findings or by making comparisons to other case studies to find similarities.

## 3.4 Article 3

The third research question was answered through a between-group experiment researching the two independent variables: types of visual presentation and types of communication. The advantages of using an experiment is that precise measurements can be created for variables [11]. Experiments are also highly replicable and give opportunity for data collection of high quality [9]. The setup created for the experiment have been described in detail, so that other researchers can replicate the study.

The disadvantages to experiments is the limited relation it has to a natural setting and an unknown level of generalizability [9]. To minimize this disadvantage the step in the experiment where the developer writes the user stories, was set up to reflect a natural setting in a meeting between developers and customers. To reflect a natural setting, the participants would be in an online meeting, or be able to send instant messages through Teams with one of the authors acting as the customer. The author acting as the customer had extensive knowledge about the case. However, this was limited by a time restriction, that might not have been present in a natural setting.

There is no well-known way of evaluating the quality of user stories, which have been a disadvantage. It was decided to take inspiration of the INVEST grid [8] to evaluate the user

stories. The overall structure of the evaluation method is the same as the INVEST grid, but the descriptions of the INVEST letters and how they should be scored were modified to better fit the experiment. The evaluation results had a low inter-rater reliability scores between the authors, meaning that the evaluation method can be improved. This implies a need for further investigation into the topic of evaluating user stories.

# 4. Conclusion

This chapter presents the conclusion of the three contributions that were made during this master thesis. First, the conclusion of the research questions will be presented. Then the problem statement will be answered. Afterwards, the limitation for each contribution will be presented, followed by future work.

## 4.1 Research Question 1

The first research question was:

> **Research question 1:** In remote requirements elicitation between customers and developers, what type of research has been conducted, and which topics have been investigated?

This was answered by the first research article. Three topics were found in the studied literature. The first topic was successes and challenges, where the found successes and challenges dealt with collaboration, knowledge management, and culture and language.

The second topic was on how different forms of communication could be used in remote requirements elicitation. The papers covered different forms such as audio, videoconferencing, wiki, text-based communication, and custom tools.

The third topic was on how different techniques could be applied in remote requirements elicitation. The papers investigated the usage of the following techniques: use cases, scenarios, wiki, requirements reuse, and automated requirements elicitation. This topic also concerned the comparison of different elicitation techniques and how to choose an elicitation technique when in a remote environment.

There were five types of research, that had been conducted in the found papers: literature review, survey, case study, experiment and the definition of a model/tool. Less than half of the papers had used an approach that tested their findings in a natural or artificial setting.

## 4.2 Research Question 2

The second research question was:

> **Research question 2:** What are the successes and challenges developers have to consider when utilizing requirements elicitation techniques adapted to a remote environment?

This was answered by the second research article. Five areas of successes and six areas of challenges have been found. The first success was concerning the selection of the right techniques, that the customer and developers find most beneficial. The second, sending things beforehand, in order to prepare the customers for upcoming online meetings. The third, no impact from observers, which were developers that were silent during the meetings, where there was found no difference between observers having their cameras turned on or off. The fourth, using design alternatives, in the prototyping and think aloud technique, which provided increased interaction and information from the customers. The fifth, setups for adaptation, where the setups used together with the techniques provided familiarity for the customers, which made it easier to utilize the different techniques.

The first challenge was the usage of an online platform, as no prior experience in a platform can be a challenge. The second, technical problems that have a risk to appear when using software tools. The third, security restrictions, as the university had setup restrictions against providing control of the mouse cursor in Teams, which would have been beneficial when using a technique in a remote environment. The fourth, smaller texts in prototypes when using screen sharing, as a problem can occur when there is a difference between monitor sizes. The fifth, a need for observation, as the technique could have clarified uncertainties about the customers' daily tasks. The sixth, comfortability can be a challenge if phones are utilized for longer meetings, as there is a possibility that holding the phone can introduce fatigue.

## 4.3 Research Question 3

The third research questions was:

> **Research question 3:** What is the effect of using different types of visual presentations and communication forms, when writing user stories in a remote environment?

This was answered by the third research article. In the article six hypotheses were presented to answer the research question. The first four hypotheses explored the effect of using visual presentation. The first hypothesis was accepted, since developers being shown visual presentations by customers, created higher quality user stories compared to the developers being shown no visual presentations. The second hypothesis was rejected, as the quality of the user stories was better when utilizing video presentation compared to photo presentation. The third hypothesis was rejected, since being shown visual presentations by customers, did not make the activity of creating user stories quicker compared to being shown no visuals. The fourth hypothesis was rejected, as developers showed no preference between the different visual presentations.

The last two hypothesis explored the effect of using different communication forms. The fifth hypothesis was rejected, since developers expressed no preference between the different

communication forms. The sixth hypothesis was accepted, as the developers asked more questions through an online meeting compared to text-based communication.

From the results of the hypotheses it can be seen that utilizing video presentation with an online meeting produced the best quality when writing user stories and increased communication with the customer.

## 4.4 Problem Statement

This section accumulate the conclusions from the three research questions, in order to answer the problem statement:

> **Problem statement:** What are the considerations developers have to make when using requirements elicitation in a remote environment?

In this master thesis there has been gathered considerations that offer insights on how to navigate the remote requirements elicitation field. These considerations implies understanding of how remote requirements elicitation can be used along with the impacting successes and challenges. The considerations has been divided into two parts, namely existing literature covered by the first research question, and practice studies covered by the second and third research question.

From academic literature it was found that remote requirements elicitation could be used with different options of synchronous and asynchronous communication forms. Furthermore, different elicitation techniques has already been tested and compared in a remote environment. The impacting successes and challenges covered the areas of collaboration, knowledge management, and culture and language.

When developers are using remote requirements elicitation in practice there needs to be an understanding of successes and challenges. The successes were selection of techniques, sending things beforehand, using design alternatives, no impact from observers, and the used setups for adaptation. The challenges were using an online platform, technical problems, security restrictions, smaller texts in prototypes, a need for observation, and comfortability. By exploring alternatives to the observation requirements elicitation technique, it was found that using video to present the customer's needs together with communication through online meetings created the best quality of user stories in a remote environment. Furthermore, the setups described in the practice studies can serve as a foundation for developers when using remote requirements elicitation.

## 4.5 Limitations

This section discusses the limitations of the work presented in the three articles.

### 4.5.1 Article 1

A limitation of our literature review has been the selective approach. A specific search engine was selected and it was decided to do no forwards and backwards search. This means that the literature review cannot be guaranteed to be exhaustive, which might have omitted certain papers, that could have highlighted other topics within the search scope.

### 4.5.2 Article 2

A limitation of the results from the case study is the usage of a semi-natural setting, where the authors acted as developers. It can be discussed if this setting reflects the work process within a software company. Another limitation is that the results presented comes from a single case study, which means that there cannot be concluded whether the results are representative for other customers and developers.

### 4.5.3 Article 3

A limitation of the experiment is the assessment of the quality of the user stories, which is reflected in the low inter-rater reliability score when using the INVEST grid. Another limitation was the setup of the experiment, because of the time limit set when the participants wrote user stories, as this might not reflect a natural setting in a meeting between developers and customers. Meaning, that the results of the experiment might not be generalizable.

## 4.6 Future Work

This section presents different areas that could be studied, in order to further the understanding of the remote requirements elicitation field.

### 4.6.1 Investigating Other Research Fields

In this master thesis it was found that only four papers regarding remote requirements elicitation was published in the last five years. This means that the number of considerations regarding newer technologies is limited within this field, meaning that further knowledge has to be found by investigating other research fields. The findings can then subsequently be used to improve the remote requirements elicitation field.

### 4.6.2 Quality Assessment Tool for User Stories

The quality of user stories has been evaluated in this master thesis. Further development in ways to asses the quality of user stories would be beneficial in not only the field of remote requirements elicitation, but also in other fields where the quality of user stories is evaluated.

### 4.6.3 Testing the Found Knowledge in Action Research

This master thesis resulted in multiple considerations for remote requirements elicitation. These considerations can be utilized in an action research study. The study could use the considerations to adapt a non-remote approach to a remote environment in collaboration with a company.

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# Appendices

# Part I

# Article 1 - Literature Review

# Literature Review on Remote Requirements Elicitation

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**Abstract**

Requirements elicitation can have a great impact on a software project, as inaccurate requirements can cause a lesser value of the software for the customers. When customers and developers are geographically separated, the process of requirements elicitation can be challenging. This paper presents a literature review that have investigated the topics and types of study that have been performed in remote requirements elicitation. An initial search resulted in 319 papers, where 31 were in the scope of this research area. Analyzing the papers revealed three topics, successes and challenges, forms of communication and elicitation techniques. These topics were investigated with five types of study, which included literature review, survey, case study, experiment, and the definition of a model/tool. It has been found that there is a limited research about remote requirements elicitation especially in the recent years.

**Author Keywords**

Requirements elicitation; Remote; Online; literature review

## I. Introduction

Requirements elicitation is a part of requirements engineering. It refers to the process of gathering information from customers and end-users in order to document requirements for the developed system.

It is important to research the field of remote requirements elicitation, as outsourcing and remote working environments has been used in software development for many years. Companies without in-house software development have applied outsourcing in order to utilize resources from already established software development companies. Other companies have focused on lowering costs on software projects, where offshore development teams in e.g. Asia, is utilized in order to reduce the expenses for wages [1]. The remote working environment has been promoted by the outbreak of COVID-19, which made remote working a necessity and online meetings became a common thing in society, and it might be seen as an option for future work environments. Following COVID-19, many companies provided their employees the opportunity to work from home, which is also seen within software development companies [2]. This working structure can also be beneficial, as it has been seen not to decrease productivity of developers during the COVID-19 lockdowns [3].

When studying remote working environments, a part of the literature focuses on the collaboration between developers that are physically separated. However, when it comes to remote requirements elicitation between customer and developer the omission of physical meetings is seen as a challenge [4, 5]. The cooperation between customer and developer in a remote environment is interesting to study further as the challenges encourages adaptation of existing requirements elicitation techniques to an remote environment. The primary objective when doing remote requirements elicitation is to incorporate different communication media such as email, instant-messaging, document sharing, audio calls, and video calls, in new ways to overcome the issues that can arise when working remote. These issues can entail knowledge sharing and communication.

This paper presents a literature review that have investigated requirements elicitation in the context of developers and customers being geographically separated. This context will be referred to as 'remote'. The topics of the papers found will be presented and at the same time the type of research approach used will be examined.

In the following section, previous literature reviews within remote requirements elicitation are outlined. Then a description of the method used to investigate the existing literature is presented. The results section gives an introduction to the information gathered from the selected literature. Next the results will be discussed in the context of remote requirements elicitation.

## II. Related Work

Investigating existing topics in the literature within the area of remote requirements elicitation has been done in different contexts. A literature review identified the factors that have influenced requirements engineering in Offshore Software Development Outsourcing (OSDO), where projects are outsourced to other countries e.g. to increase profits due to cheaper labor cost [6]. The outcome of the review was 25 success factors, where six of those were identified as critical. A success factor was identified as critical when it appeared in the literature with a frequency of 50% or more. The critical success factors were trust building among stakeholders, communication and coordination between teams, process improvement awareness, governance and control of requirements elicitation activities, need for standards and procedures, and resistance management. These critical success factors were validated afterwards through a questionnaire in a survey, which found that 70% or more participants were positive towards the 25 success factors identified in the literature review. The highest scoring success factor in the survey was trust building between stakeholders where 87% of the participants were positive towards this.

The identified success factors of communication and its practices in Software Development Outsourcing (SDO) requirements engineering have been investigated through a literature review [7]. They found 27 communication issues and 24 relevant practices for requirements engineering. To accompany their literature review they asked SDO practitioners through a questionnaire about which issues and practices they encountered. The survey revealed 5 communication issues and 4 relevant practices. Their work resulted in a formulation and evaluation of a framework to address the communication issues. Video conferencing or teleconferencing is proposed as a practice to overcome issues related to distance. However, they have seen that sometimes video conferencing can be unproductive and should be supported by asynchronous communication. Furthermore, adding asynchronous communication can give extra time for information processing and building common grounds.

In Global Software Development (GSD) a systematic literature review on types of studies have been performed [8]. They have found that the research approach in the majority of the papers were case studies (40%) and experiments (27%). While the rest were composed of non-experimental (12%), survey (9%), and literature reviews (5%). Here, non-experimental covers studies that have proposed a model without doing any testing. These papers had used participants from the industry (40%), the university (16%), and organizations that were not specified (6%). The rest of the papers (38%) had no participants.

The use of online requirements elicitation in the context of COVID-19 pandemic has been explored, with a focus on corporations' adaptations to online platforms such as Microsoft Teams and Zoom [9]. Through a literature review they have collected information on different types of techniques used in requirements elicitation when physical meetings are no longer an option. This was followed by a presentation of ways to exploit the elicitation techniques in online meetings along with an estimation of benefits and risks when comparing physical- and online meetings. They compare the cost and time of conducting physical and online meetings and found that doing online requirements elicitation saved time and were more cost efficient.

The existing literature on remote requirements elicitation is limited and not all the literature have a focus on the interaction between developer and customer. Some of the literature instead focuses on part of it, such as remote requirements engineering without a focus on the collaboration between developers and customers.

## III. Method

The method for the literature review is based on a framework defined by vom Brocke et al. [10]. Below is a description of how the 4 phases in the framework have been used.

### Phase 1: Definition of review scope

The purpose of this literature review is to find the research outcomes and methods of the existing literature within the area of 'remote requirements elicitation'. In this paper this area is defined as requirements elicitation utilized by developers, which are geographically separated from the customer.

### Phase 2: Conceptualization of topic

To gain an understanding of the defined research field, the areas requirements elicitation methods and remote requirements elicitation were investigated. The investigation revealed that the area of remote requirement engineering covers a variety of topics. The investigation also revealed that the term remote can be described with the terms 'distributed' and 'offshore'. These terms also describe the working constellation in a development team. This has to be considered for the literature search as the focus is the remote relation between customer and stakeholder.

### Phase 3: Literature search

When constructing the search string different databases and journals were trialed. This included Elsevier's Scopus, Google Scholar, ADM Digital Library and IEEE Electronic Library. Elsevier's Scopus was selected as it is the largest single abstract and indexing database [11], and it searches in a variety of high ranking jour-

nals and conferences within software development. It also contains extensive search filter that allows the user to search for terms separately in e.g. keywords, title, or abstract.

The final search string is depicted in Figure 1. It captures both the scope of the literature review along with alternative terms obtained in the conceptualization phase.

```
( ABS ( "requirement engineering" OR "requirements engineering" )
AND ABS ( remote OR off-shore OR offshore OR distributed )
AND TITLE-ABS-KEY ( software ) )
```

**Figure 1:** Search string used in literature search on Scopus.

To ensure that the relevant papers for the scope was found a broad search was chosen. The term 'requirements engineering' was selected instead of the more specific term 'requirements elicitation'. This was done to include articles that studied the whole process of requirements engineering and not just elicitation. The terms 'remote', 'off-shore', 'offshore', and 'distributed' are chosen to capture the definition of being remote. The terms are chosen with the knowledge, that literature covering working constellations outside the review scope has to be excluded later. The term 'software' had to be in the title, abstract, or keywords in order to narrow the search to only focus upon the area of software development.

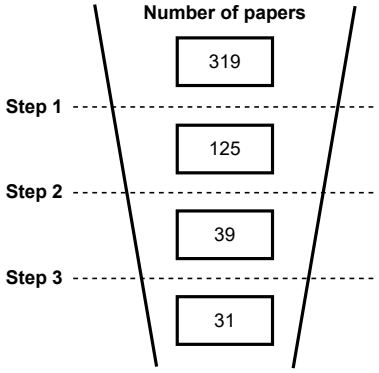


**Figure 2:** Paper selection steps in phase 3 of the literature review.

The literature search on Scopus resulted in 319 publications. The selection of the relevant publications was done through three steps, visualized in Figure 2. A description of each step can be seen below:

Step 1: Title and abstract (1 pers./1 paper)

In this step, the title and abstract of the papers in the 319 publications were read. A paper was excluded if it did not fall under the review scope. For example papers would be excluded if they only covered the areas of distributed software or working distributed in a software development team. From this process 125 papers were eligible at this stage.

Step 2: Skimming (1 pers./1 paper)

The papers in this step were skimmed by one person each. A paper was selected if the author found it to be within the scope of remote requirements elicitation between developers and customers. An excluded paper would be labeled with a description of the reason. An example of a label for an excluded paper could be 'Between development teams', which means that the paper is outside the review scope, because it has no focus on the contact between customers and developers. At the end of step 2 there were 39 papers.

Step 3: Labeling (1 pers.)

In the last step, one author read through the remaining 39 papers. This person labeled each paper with keywords that describes the focus along with the type of study that has been conducted. Any uncertainties was discussed with the 2 other authors. Through this procedure, a number of papers were also excluded, either for being duplicates or being outside the scope of requirements elicitation between developers and customers. Each exclusion was reviewed by the other two authors. After this step 31 papers remained eligible.

### Phase 4: Literature analysis and synthesis

In this phase the papers selected through the literature search were analyzed and synthesized. This was done in order to find overall topics and get a list of which types of study that have been conducted. The process started with the assigned labels from the third step of the literature search. The labels were divided in topic and types of study. Labels that were related to each other were grouped together. This step resulted in a total of 3 overall topics, where each paper can be related to more than one topic. All the papers were also divided into a list of 5 different types of study, where each paper can use more than one study.

## IV. Results

This section presents the results obtained from the literature review. Table 1 gives an overview of the selected 31 papers organized in the 3 topics within remote requirements elicitation. Furthermore, the type of research approaches used in the found papers will be presented.

| Topic | Articles | No. |
|---|---|---|
| Successes and challenges | [12] [6] [7] [13] [14] [15] [16] [17] | 8 |
| Forms of communication | [9] [18] [19] [20] [21] [22] [23] [24] [25] [26] [27] [28] [29] | 13 |
| Techniques | [30] [31] [32] [18] [33] [21] [22] [34] [35] [36] [37] [38] [39] [26] [28] [29] | 16 |

**Table 1:** Papers organized between the 3 overall topics. A paper can belong to more than one topic.

In Figure 3 the papers have been divided in year ranges. It can be seen that most papers are in the range from 2008 to 2012.

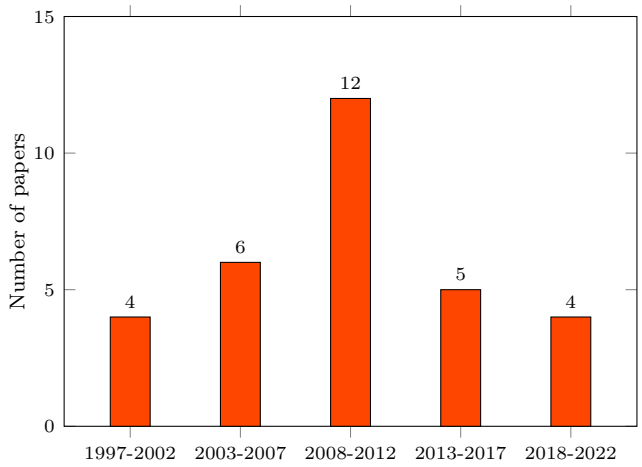


**Figure 3:** Papers divided in year ranges.

Figure 4 shows the distribution of topics within the year ranges. 'Techniques' is represented by the most number of papers. However, none of the papers in the last five years represent this topic.

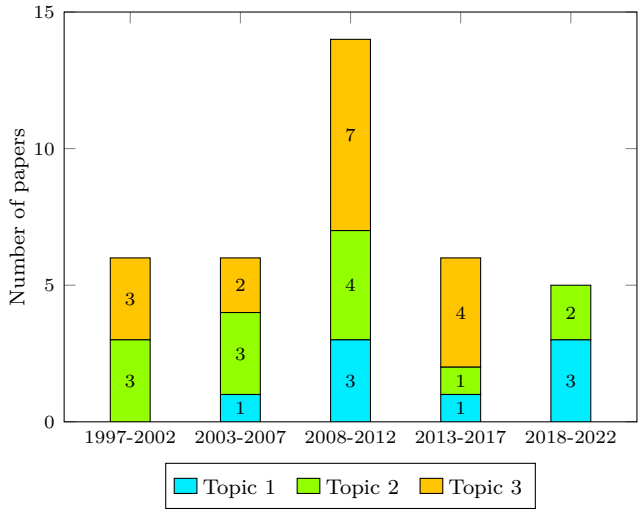


**Figure 4:** Papers divided in year ranges and topics. A paper can cover multiple topics.

### Topic 1: Successes and challenges

This topic is mainly covered by literature reviews and surveys that identify successes and challenges of being remote. An overview of the most prominent areas for successes and challenges in remote requirement elicitation can be seen in Table 2.

| Area | Papers |
|---|---|
| Collaboration | [12] [6] [7] [15] [16] [14] [17] |
| Knowledge management | [15] [16] [17] |
| Culture and language | [13] [15] [16] |

**Table 2:** The areas of successes and challenges found in the papers.

#### Collaboration

Collaboration between customers and developers is identified to be a potential challenge, that is increased by distance. For example, it has been seen that distance limits the ability to identify stakeholders [12]. Trust is also identified as a success factor, which can be impacted by infrequent communication between customers and developers [6]. Requirements elicitation literature supports in-person meetings, as the preferred communication form [7]. This is challenged in remote requirements elicitation by the distance between customers and developers. It is argued that informal communication is lost when requirements elicitation is not performed in-person [15, 16].

#### Knowledge management

Good knowledge management is identified as a factor for the success of remote requirements elicitation. The documentation of the elicitation process is important, as it avoids misunderstandings [17] and makes it possible to share knowledge between stakeholders [16].

#### Culture and language

When the distance between developers and customers go beyond national boarders, challenges can arise because of a difference in native language and culture. The use of different native languages can in some cases cause misunderstandings [13, 15, 16]. A cultural challenge can be the expectation and perception of work ethics, which can cause tension [13] and can lead to lack of collaboration [16].

### Topic 2: Forms of communication

Communication is an important factor in remote requirements elicitation and the usage of different forms of communication have been researched in the literature. These can be divided into synchronous and asynchronous communication. Asynchronous communication is comparable with the usage of emails where information is not shared instantly, while synchronous communication is comparable to being synced up in time e.g. with a phone call. An overview of the communication areas and forms can be seen in Table 3.

| Area | Form | Papers |
|---|---|---|
| Synchronous communication | Audio | [26] |
| | Video conferencing | [9] [27] |
| | Text-based | [19] [23] |
| | Tools | [18] [20] [28] |
| Asynchronous communication | Text-based | [24] [25] |
| | Wikis | [21] [22] |
| | Tools | [29] |

**Table 3:** Papers in forms of communication dived in topics.

### Synchronous communication

The synchronous communication forms found in the papers include audio, video conferencing, text-based, and tools. The synchronous forms of communication require that all participants are available at the same time.

Audio: When using audio communication in relation to different requirements elicitation techniques, a Q and A approach was deemed the most effective by the participants and most importantly they found that the gathering of requirements were most effective when customers participated actively in the synchronous activities [26]. However, the participants had not utilized all of the researched techniques, as an example prototyping was valued low, but it had not been utilized in this study.

Video conferencing: The use of video conferencing imitates an in-person meeting with the limitation, that body language can be hidden, which can make communication more difficult. Video meetings introduces a more formal environment, which make meetings shorter due to the lack of informal conversations [27]. From this experimental setup it was noted, that video conferencing made it easier to follow the conversation, as only one person can speak at a time.

Shifting from a in-person environment to a remote environment by using video conferencing introduces increased flexibility in the scheduling of meetings [9]. This study also proposed an algorithm for calculating the cost of doing physical meetings versus online meetings. The algorithm takes into account initial cost, operating cost, cost of failure, and cost of maintenance when setting up the remote working environment. Time and cost savings will depend on the distance between customers and developers, as the savings will increase with greater distances.

Text-based: A study have compared synchronous text-based communication with in-person conversation [19, 23]. An experiment was setup and afterwards the participants were surveyed about their comfort and satisfaction with the communication form. Based on satisfaction, there was a preference towards in-person conversation when doing requirements elicitation. The survey also showed that participants felt an elevation in their own participation in discussions when using the text-based approach throughout the requirements elicitation activity. The participants also felt that more opportunities presented themselves to engage in discussions when using the text-based approach.

Tools: Different tools have been proposed to aid the communication in remote requirements elicitation. To overcome language barriers, real-time machine translation have been investigated through an experiment [20]. The answers from the participants indicated that the machine translation did not interrupt the flow of the conversation. The answers showed no difference in the interaction between the participants using the machine translation and the participants communicating without the aid of machine translation. However, it was noted that the machine translation sometimes had problems, and it was necessary to rephrase sentences, which can have a negative impact on the conversation flow.

Another tool introduced the combination of a synchronous text-based chat function and a shared drawing tool, which can be used together with requirements elicitation techniques [18].

A groupware tool was suggested for remote requirements elicitation, where the main idea is to have a room-based approach with working and meeting spaces [28]. The tool have shared whiteboards, brainstorming, voting, file sharing, and different types of note systems. Communication in this tool is text-based via a chat function, where it is possible to see what people in the same room are looking at.

### Asynchronous communication

The asynchronous communication forms found in the papers were text-based, wikis, and tools. An advantage of asynchronous communication is that participants do not have to be available at the same time. A disadvantage of asynchronous communication can be that misunderstandings cannot be clarified immediately.

Text-based: A cross country study investigated whether asynchronous text-based communication can improve the collaboration in software development by making common ground before synchronous meetings [24]. They found that issues with requirements often were resolved before the synchronous meetings, when using asynchronous communication before the meetings. Furthermore, more requirements issues were resolved during the meetings, when asynchronous communication had been done before the meetings. This result was suggested to be because of the common ground, that was established before the synchronous meetings.

The use of text-based asynchronous communication in remote requirements elicitation can ensure consistency

and contribute to knowledge management, as it improves traceability and provides structure to the process [25].

Wikis: Wikis are seen as a supporting tool in the requirements elicitation activity. They are used to share knowledge, gather information, and document requirements. This enables stakeholders to participate more directly in the requirements elicitation activity. The use of wikis are not restricted to be only text-based communication, as audio recordings can be implemented to enable traceability of the rationales behind the requirements [21]. Wikis can also enable version control, which is an advantage when more people can edit.

Wikis are proposed as a place for asynchronous collaboration in the form of an requirements overview with the possibility of commenting on the requirements asynchronously [22].

Tools: Another way of communicating asynchronously can be with a suggested tool that uses video clips to further elaborate on specific requirements [29]. This gives a visual element in the asynchronous communication.

### Topic 3: Techniques

This topic covers different areas of techniques, which have been studied to see their performance in the area of remote requirements elicitation. Furthermore, two studies have compared different elicitation techniques in a remote environment and another investigated the selection of elicitation techniques.

| Area | Papers |
|---|---|
| Use cases and scenarios | [18] [39] |
| Wikis | [21] [22] [35] [36] [38] |
| Requirements reuse | [30] |
| Automated requirements elicitation | [31] [32] [34] [29] |
| Comparing techniques | [33] [26] |
| Selecting techniques | [37] |

**Table 4:** Papers organized in different areas. The first four areas concerns different requirements elicitation techniques. The last two areas concerns comparing multiple techniques and selecting the correct technique.

In Table 4 the elicitation techniques utilized in the papers have been listed. It can be seen that four different areas of techniques were investigated in the context of remote requirements elicitation.

#### Use cases and scenarios

Use cases and scenarios have been investigated in two papers finding that the quality did not decrease when being applied in remote requirements elicitation when compared to in-person conversation [18, 39]. The remote conversation was text based utilizing groupware tools. It was found that the time used to produce the use cases/scenarios were significantly lower when using in-person conversation compared to using text-based chat [18].

#### Wikis

Wikis were the most investigated technique in the papers found. Wikis have been utilized to share knowledge and document the information gathered in the requirements elicitation activity [21, 36, 38]. The papers show how different types of wikis can be implemented in remote requirements elicitation. Wikis can be used in combination with other technologies, such as audio recordings [21] and linking requirements to domain knowledge [35, 36] The advantages of using wikis were found to be the possibility of working asynchronous, supporting traceability, having rationale management, and providing a common understanding [21, 22, 36, 38]. A semantic wiki ensures consistency of documents and requirements. It has been found to express the content in a form that enhances search precision and logical reasoning, as a traditional wiki's metadata infrastructure are lacking and information are handled along the way [22]. Furthermore, it was preferred in remote requirements elicitation, as it showed the ability to improve common ground between stakeholders [35].

#### Requirements reuse

Requirements reuse is when requirements used for another project is applied in a new project. One paper has investigated how requirements reuse will perform in remote requirements elicitation [30]. This was done through an experiment with students in both remote and co-located environments, comparing reuse and non-reuse requirements. The study showed a higher effectiveness for the remote students compared to the co-located students, but productivity was lower for the remote students than for the co-located students. Effectiveness was measured on the quality of the product by one of the authors scoring the product through a four-point scale. Productivity was measured as number of requirements per hour.

#### Automated requirements elicitation

Automating the task of requirements elicitation or parts of it can save time and money. This can be efficient when a large groups of stakeholders are involved in a project. Four papers have investigated how automated requirements elicitation can be implemented in a remote environment. Two papers proposed a model for a systematic use of automated requirements elicitation techniques to elicit requirements from crowds of stakeholders [31, 32]. These techniques included crowdsourcing, text mining, and data mining. Furthermore, automated requirements elicitation can be used by implementing a recommender system to facilitate collaboration with the stakeholders along with data min-

| | Literature review | Survey | Case study | Experiment | Model/tool |
|---|---|---|---|---|---|
| **Papers** | [9] [6] [13] [14] [15] [16] [7] [25] [33] | [12] [6] [7] [33] | [17] | [30] [18] [19] [20] [34] [38] [23] [24] [39] [26] [27] | [31] [32] [21] [33] [22] [34] [35] [36] [37] [28] [29] |
| **Number of papers in %** | 29% | 16% | 3% | 35% | 35% |
| **Number of papers** | 9 | 4 | 1 | 11 | 11 |
| **Participants from industry** | | 4 | 1 | 2 | |
| **Participants from university** | | 0 | 0 | 10 | |

**Table 5:** Papers organized in types of study. A paper can utilize more than one type of study. The number of papers percentage is relative to the total amount of papers in the literature review. A paper can have participants from both industry and university.

ing. This was proposed for large scale software projects where stakeholders can be distributed [34]. Optimizing the workflow in remote requirements elicitation by automating scheduling of work tasks has also been proposed [29].

#### Comparing techniques

Two papers have compared different types of remote requirements elicitation techniques by surveying customers [33] and students [26] that had participated in a experiment through a questionnaire. In one paper prototyping was valued as the one providing the highest effectiveness based on customer satisfaction [33], while a Q & A technique was rated the most effective in the other paper [26].

#### Selecting techniques

One paper focused on the formulation of a model that helps select a requirements elicitation technique when doing remote requirements elicitation [37]. The model takes different parameters into account such as stakeholders' preference, language skills, and the individual stakeholder's role in the requirements elicitation activity.

### Types of study

This section presents the types of study used in the papers from the literature review. An overview can be seen in Table 5, where the papers are organized by type of study. A paper can contain multiple studies. The 'Literature review' category consists of papers that have done literature reviews and literature surveys. The category 'Survey' has been defined as papers that have done studies, which have collected data through systematic techniques such as questionnaires [40]. 'Case study' has been defined as papers, that have done studies in a natural setting. 'Experiments' has been defined as papers that have done studies in an artificial setting with controlled variables [40]. The 'Model/tool' category consists of papers that describe a developed model or tool designed to be used in remote requirements elicitation.

Most papers used the types of study 'Experiment' and 'Model/tool', with eleven papers each. This was followed by 'Literature review' with nine papers. 'Survey' and 'Case study' was used by the least number of papers with five and one respectively. For the surveys and the case study only participants from the industry were used. One experiment used participants from both the industry and the university. Furthermore, nine experiments had only used participants from the university and one experiment had only used participants from the industry. The proposed models and tools were for the most part not tested in the papers, as only one paper had tested the proposed model through an experiment.

## V. Discussion

In this section the findings will be discussed. The aim of this literature review were to investigate the topics and which research approach, that was used in the research field of remote requirements elicitation. First, the topics found will be discussed and afterwards the types of study found will be discussed. In the end, there will be a discussion about the limited amount of papers in recent years.

### Topics found

This section discusses the papers within each of the found topics.

#### Successes and challenges

The found areas in this topic can be seen as broad, but this is affected by the abstract descriptions in the papers, as each success and challenge has not been described on a granular level. The findings from the papers can be seen more as guidelines instead of actual solutions to the challenges, which limits the usefulness for practitioners.

#### Communication forms

The found papers dated back to 1997. As an example video conferencing has been considered costly [19, 23, 24], which is probably not true with the current usage of online meetings. Furthermore, the investigation

of newer technologies could only be found in one paper [9], which mentions the usage of Microsoft Teams, Google Meet, and Zoom. This means there is a lack of research regarding newer technologies within the remote requirements elicitation field.

#### Techniques

From the papers, it was found that only four areas of requirements elicitation techniques had been investigated within remote requirements elicitation. This means that many of the current elicitation techniques such as focus groups, observation, and protocol analysis have not been investigated within a remote environment [41]. There was also contradictions in the papers about effectiveness, as one paper valued prototyping high [33], while it was scored low in another [26]. This might have been influenced by the evaluation criteria, as the participants which had scored prototyping low had not used the technique. When it was valued high, it was based on a subjective assessment of the satisfaction of a customer. However, this evaluation was not described in detail, which also leaves uncertainties about the scoring.

### Observations on types of study

There was found five different types of study when investigating the papers from the literature review. Another paper have investigated the types of study done in GSD through a literature review [8]. The paper found that 47% had done case studies, which is a contrast to this literature review, where only 3% had done case studies. There was also a big difference between number of papers that had done literature review, with 5% in their literature review and 29% in this literature review. When looking at the distribution of types of study it can be noted, that less than half of the papers have used an approach that is either in an artificial or a natural setting.

In this literature review 10 out of 31 papers (32%) used participants from a university, which is higher compared to the literature review concerning GSD, where it was 16% [8].

From this literature review, it was also found that 7 out 31 papers (23%) used participants from the industry, which is lower compared to the literature review on GSD, where it was 40% [8].

The reason for using participants from a university can be that it is easier to recruit students instead of professionals from the industry. It can also be debated whether the results from the papers that have used students can be transferred to a natural setting. This has been investigated by one paper, which showed that software professionals performed better than students when having experience with the work approach in an experiment [42]. However, when using a new work approach, the performance were similar for software professionals and students [42].

### Few papers in recent years

From Figure 3 it can be seen that only four papers were found within the last five years. This means that knowledge regarding newer technologies is not represented e.g. the usage of Teams or Zoom has not been properly investigated within remote requirements elicitation.

## VI. Conclusion

This paper presents the findings from a literature review, that investigates which topics and types of study, that have been researched in remote requirements elicitation. From the literature search 31 papers were found to be about remote between developers and customers when performing requirements elicitation. From these 31 papers three topics were found: successes and challenges, communication and elicitation techniques. Additionally, five types of study were found in the papers: literature review, survey, case study, experiment and the definition of a model/tool. Here, less than half of the papers had used a natural or artificial setting.

This study has shown that the knowledge regarding remote requirements elicitation is limited and there is a lack of knowledge about the possibilities in the recent years.

The literature search is not exhaustive, which means that some papers may have been omitted, meaning that the findings can be build upon.

In future studies it could be interesting to investigate other research fields regarding new technologies that have become commonplace after COVID-19, as the research within remote requirements elicitation is limited. This should be done in order to find other possibilities on how to adapt requirements elicitation to a remote environment.

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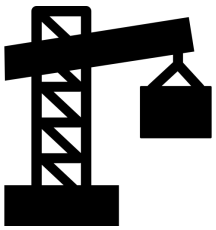
# Part II

# Article 2 - Case Study



# Successes and Challenges when Utilizing Requirements Elicitation Techniques Adapted to a Remote Environment

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## Abstract

In recent years, there has been a shift towards a remote work environment mainly due to the COVID-19 pandemic. After the pandemic had lifted, the remote work environment has remained, leading to the need for adaptations in areas such as requirements elicitation, where different technical platforms, such as Teams, has to be used together with techniques like interviews, prototyping, scenarios and think aloud. The objective of this study is to investigate successes and challenges developers have to consider when adapting these techniques to a remote environment. This was done through a case study with a Danish company, that provides service of cranes, acting as customers and the authors acting as developers. The results showed 5 successes, which includes selection of techniques, sending things beforehand, using design alternatives, having observers, and the used remote setups. Additionally, 6 challenges were found concerning technical aspects, comfortability and propositions for using observation techniques.

## Author Keywords

Requirements elicitation; remote; online; case study; autoethnography; successes and challenges

## I. Introduction

Requirements elicitation is an important step in the software development cycle. It is part of requirements engineering, focusing on collecting information about the needs of the customers, which is then used when specifying the requirements for the developed system [1].

In the recent years developers have been forced to work remotely due to the COVID-19 pandemic [2]. During the COVID-19 pandemic, remote work became an alternative, which could be used in the future beyond the pandemic [2]. This has also been reported by Stack Overflow [3], which conducted a survey asking developers about their work constellation, where around 43% stated they worked fully remote in 2022. Here, it should be said that the number could be influenced by forced remote work as not all countries were over the COVID-19 pandemic.

Due to this shift to working in a remote environment, it is important to look at the adaptation of existing requirements elicitation techniques looking at both successes and challenges. This should be done in order to give an overview for practitioners when they start working remotely.

Adaptations for requirements elicitation techniques in a remote environment have been investigated before through a literature survey, where propositions were given for a number of techniques, including interviews, questionnaires and focus groups [4].

The investigation of successes and challenges has also been done before. A literature review has been done in order to compare the success factors reported in existing literature with responses from a questionnaire survey study [5]. There has also been investigated different elicitation techniques according to their competence and effectiveness in relation to different challenges and customer satisfaction in Global Software Development (GSD) [6].

At the time of writing no case studies have been performed to identify successes and challenges when adapting requirements elicitation techniques to a remote environment. This paper presents a case study with a Danish company, investigating the successes and challenges developers have to consider when utilizing requirements elicitation techniques adapted to a remote environment, between customers and developers.

In the following section, related work is outlined. Afterwards, there is a presentation of the selected requirements elicitation techniques used in the case study. This is followed by a description of the method used in the case study. The result section presents the information gathered in the study. The discussion will present the successes and challenges found in this study.

## II. Related Work

This section presents existing literature, that focuses on the interaction between developers and customers within remote requirements elicitation. The literature is divided into two aspects, adaptation to a remote environment and successes and challenges. Furthermore, it should be mentioned that the existing literature focusing on these two aspects is limited.

### Adaptation to a remote environment

One paper conducted a literature review in order to discover which requirements elicitation techniques are used when switching to a remote environment, where they found the following techniques: interviews, questionnaires, focus groups, and Joint Application Development (JAD) [4]. They also presented ways these techniques were adapted using digital platforms such as Microsoft Teams, Google Meet, or Zoom, e.g. by showing PowerPoint presentations or sharing the screen to show code or a program.

Another paper have investigated the usage of different communication technologies to utilize in a remote environment, comparing face-to-face in-person and text-based communication, to find out which one is more appropriate in the requirements elicitation activity [7]. They utilized an empirical study with six academic groups involved in an undergraduate requirements engineering course. Data was collected through a questionnaire along with interaction logs and requirements specification documents. It was found that face-to-face is not always the preferred medium when being involved in requirements activities. Secondly, they found that the outcomes of the requirements elicitation activity shows no influence from the choice of communication medium. Thirdly, requirements elicitation was seen as the activity with the highest probability of success for implementing text-based communication, when compared to requirements negotiation.

### Successes and challenges

A paper researching Offshore Software Development Outsourcing (OSDO), investigated the success factors and challenges for requirements engineering [5]. They found 25 success factors through a systematic literature review. This was followed by a questionnaire-based survey where the success factors were validated with practitioners, and 6 success factors were found most critical. Through this process they further classified the success factors for different organizations based on their type, client or vendor, or their size. Here, size and type indicated small differences.

Another paper have surveyed existing approaches for eliciting requirements along with challenges in the remote environment experienced in Global Software Development (GSD) [6]. Through a literature review they created an overview of requirements elicitation techniques used in GSD, which included interviews, questionnaires, prototyping, and scenarios. They presented their ability to solve a set of 10 different problems such as stakeholder identification and time constraints, through a scoring system categorized in best, fair and satisfactory. This paper also presents a study, where a number of software houses have been surveyed to find the most effective elicitation techniques in GSD based on customer satisfaction. In total 4 techniques were found the most effective. They found that prototyping provided the highest customer satisfaction with 90%. It was followed by scenarios with 70%, interviews with 60%, and questionnaires with 30%. The interpretation of how these numbers represent effectiveness are not completely clear in the paper, as it is presented as both customer satisfaction in relation to the output of a development process, and the chance for customers to be satisfied, thereby, making the purpose of the results uncertain.

## III. Requirements Elicitation Techniques

The requirements elicitation techniques used in this study have been selected from a collection defined by Zhang [8] with an addition of think aloud. The selection was made based on which techniques could provide information about the customers' needs and showcase ideas for the developed system.

### Interviews

Interviews gives an insight into the customers' current work process and their attitude towards the developed product, which helps get an understanding of their requirements [8]. When a predefined guide or agenda is utilized in an interview it is called a structured interview, otherwise, it is called an open-ended interview.

### Prototyping

This technique brings the customers a visual representation of the (partial) developed product, often used to validate and elicit requirements [8]. A number of approaches can be used for prototyping including storyboards, executable, throwaways and evolutionary, each requiring different levels of effort [9].

### Think aloud

This technique lets the customers express their thoughts aloud, while solving tasks in the developed system, introducing a way to analyze user behavior in early stages of the development [10].

### Scenarios

Scenarios are held as sessions where the developer gives the customer a description of actions and events for a selected task within the developed system [8]. They

| Activity | Phase | Weeks | Customers | Techniques | Adaption to remote |
|---|---|---|---|---|---|
| **Start-up meeting** | **Introduction** | **36-39** | TM, FM & PL | | |
| **Prioritization meeting** | | | TM & PL | | |
| **Semi-structured interviews** | **Interviews** | **40-42** | SE, SP & PL | Interviews | Online meetings in Teams |
| **Prototype construction** | **Prototyping** | **43-47** | | | |
| **Showcase app** | | | SE | Think aloud & Prototyping | Online meetings in Teams, screen-sharing |
| **Showcase website & app** | | | TM, TC & TC | Prototyping | Online meetings in Teams, screen-sharing |
| **Specify requirements** | **Requirements** | **48-50** | | | |
| **Present requirements** | | | TM | | |

**Table 1:** Overview of the phases and activities done in the collaboration with the company. For each activity we have shown the customers who participated along with the used requirements elicitation techniques and their adaption to remote. Cells has been crossed out if no customers participated or no requirements elicitation techniques were used.

can be shown through different mediums, such as text or pictures [9]. Alternatively, they can be structured through use case diagrams [11].

## III. Method

This section begins with research practice, which explains the case study made in collaboration with a Danish company that provides service of cranes in different sectors. This is followed with a description of how the data is collected and analyzed.

| Job title | No. | Description |
|---|---|---|
| Technical Manager (TM) | 1 | Management responsible for the technical areas within the company. |
| Financial Manager (FM) | 1 | Management responsible for the financial areas within the company. |
| Planner (PL) | 1 | Administration responsible for scheduling work for the service engineers. |
| Training Coordinator (TC) | 1 | Administration responsible for scheduling courses for the service engineers. |
| Service and Project Manager (SP) | 1 | Technical personnel managing the technical areas of the service engineers' work. |
| Service Engineer (SE) | 5 | Technical personnel providing service for cranes. |

**Table 2:** Overview of people participating from the company, referred to as customers in our collaboration.

### Research practice

The company participated in the requirements elicitation activity acting as customers, and the authors acted as developers.

Throughout the collaboration a selection of requirements elicitation techniques were utilized in a remote environment. The collaboration involved people in different branches of the company, which included management, administration, and technical personnel. An overview of the people participating from the company can be seen in Table 2. They will be referred to as customers going forward.

The case study started in September 2022 and ended in mid December 2022. During this period four phases were conducted with a number of activities, presented in Table 1. The first phase was used to find the specific areas that the company wanted to improve through software. In the next two phases, the selected requirements elicitation techniques were utilized. The last phase was used to present the gathered requirements.

Below is a description of all the activities conducted in the phases.

#### Start-up meeting (07-09-2022, ca. 1 hr.)

This meeting was held at the company physically, where the collaboration with the company was established. In the meeting, there was an agreement on the collaboration and a common understanding on continuing further communication in a remote environment through Teams [12] and email. Teams was chosen as a medium for communication as it was already incorporated into the company.

#### Prioritization meeting (30-09-2022, ca. 1 hr. 30 min.)

This meeting was held online through Teams three weeks after the start-up meeting. In this meeting the customers presented a list of daily tasks they wanted streamlined through software. In the end, it was decided to focus on tasks within the area of personnel- and calendar management.

#### Semi-structured interviews

This activity covers the usage of interviews as a requirements elicitation technique. Semi-structured interviews were utilized and an overview can be seen in Table 3.

| Date | Customer | Time - h:mm | Observers |
|---|---|---|---|
| 05-10-2022 | PL | 0:55 | Camera off |
| 10-10-2022 | SE-1 | 0:20 | Camera on |
| 12-10-2022 | SE-2 | 0:17 | Camera off |
| 17-10-2022 | SE-3 | 0:19 | Camera off |
| 17-10-2022 | SP | 0:19 | Camera off |
| 17-10-2022 | SE-4 | 0:11 | Camera on |

**Table 3:** Overview of semi-structured interviews.

The interviews were setup as online meetings through Teams, where each meeting was between the developers and a single customer. In each interview, one of the developers would be the interviewer, and the other two would be observers. One of the observers would take notes capturing important statements from the customer. During the interview, both the interviewer and the customer would have their cameras turned on.

In two meetings observers had their cameras on as can be seen in Table 3. In the end, it was decided to have the cameras turned off for the observers in the following phases. This was mainly due to no perceived difference for the developers and the customers having the cameras turned on or off.

Before every interview, questions were sent to the customer in advance. This was done in order to give them additional time to reflect upon the questions and their answers.

#### Prototype construction

Two weeks were used to construct prototypes from the information gathered in the previous phases. In total two prototypes were created, one depicting an app for the SEs, the other one a website for the administration and management.

Figma [13] was used to design the prototypes, which allowed for them to be interactive. This included navigation and actions such as scrolling in order to simulate a finished product.

#### Showcase app

In this activity, the app prototype was showed to four SEs. An overview of the meetings can be seen in Table 4.

| Date | Customer | Techniques | Time - h:mm |
|---|---|---|---|
| 08-11-2022 | SE-5 | Prototyping | 1:02 |
| 11-11-2022 | SE-4 | Prototyping & Think aloud | 0:40 |
| 15-11-2022 | SE-3 | Prototyping & Think aloud | 1:40 |
| 17-11-2022 | SE-2 | Prototyping & Think aloud | 0:54 |

**Table 4:** Overview of meetings for showcasing the app.

The prototyping requirements elicitation technique was utilized as the basis for this activity. After the first meeting, the think aloud technique was also used to allow the customers to state their opinions when interacting with different design alternatives in the app prototype.

The scenarios technique was meant to be used in this activity to provide the customers with a systematic overview of the functionality in the prototypes. This would be done by presenting use cases that depicted the actions and events in the prototypes. However, in the end it was chosen to exclude scenarios from the activity because of time considerations. Instead, the use cases were presented as part of the data collection to get their opinions on the technique.

For the prototyping technique Teams meetings were utilized, along with the screen-sharing functionality. This approach was chosen, as the developers had experience showcasing visual elements through Teams in other university projects.

For the think aloud technique there were two alternatives, the first one being the customers accessing the prototypes online in Figma themselves, and then show the prototypes through screen-sharing allowing the developers to see how the customers navigate around in the prototypes. This approach was excluded almost immediately because it was necessary for each customer to create an account in Figma in order to access the prototypes, which was found to be cumbersome. Therefore, the second alternative was chosen, where the 'give control' feature in Teams would be used to allow the customers to move the mouse cursor around on the screen. However, this was not possible due to security restrictions, which disallowed the developers to give control to external users outside the university. Instead, the customers directed the developers around in the prototype by telling the developers where to click.

Before a meeting, a video showcasing the app prototype was sent to the customer. This was done to make the customer think about the design, layout, and information beforehand.

During a meeting, one developer would be the interviewer responsible for showcasing the prototype and asking questions. Both the interviewer and the customer would have their cameras turned on. The other two developers would be observers with their cameras turned off, where one observer would take notes during the meeting.

#### Showcase website & app

In this activity the website prototype was showcased to selected end-users, which were persons in the administration and management. An overview of the meetings can be seen in Table 5.

| Date | Customer | Time - h:mm |
|---|---|---|
| 22-11-2022 | TC | 1:35 |
| 23-11-2022 | TM | 1:36 |
| 24-11-2022 | PL | 1:20 |

**Table 5:** Overview of meetings for showcasing the app and the website.

It was chosen to only utilize the prototyping technique in this activity, because the website had not been implemented with enough navigation mechanisms in order to reflect a finished product, which invalidated the usage of the think aloud technique.

For this activity the same setup was used as presented in the showcase app activity. However, in order to give context to the website prototype the app prototype was showcased first in each meeting in this activity. The TM was also shown a system overview in order to discuss the current setup within the company, and how it could be modified to work with the new system.

#### Specify requirements

Two weeks were used to create a requirements specification document. During this time the prototypes were also updated to make them conform with the information gathered in the prototyping phase.

The focus was on describing the design and actions in the specification. For the integration with the existing systems it was chosen to make abstract descriptions. Details on functionality or software to use was omitted, as the focus in this case study was not on implementing the system.

#### Present requirements (12-12-2022, 1h. 14 min.)

This meeting was used to conclude the collaboration with the company. During the meeting the requirements specification document was presented in order to give an overview of the gathered requirements.

### Data collection

This section explains the process behind the data collection starting with the perspective of the developers through autoethnography. This is followed with the perspective of the customers from the company, collected through customer feedback sessions.

#### Autoethnography

The role of the developers is taken by the authors of this paper. Autoethnography was utilized since it lets people document their actions and reflections when participating in a study. Autoethnography combines characteristics from both autobiography and ethnography, where a researcher describes selective occurrences, which takes place when being part of a culture [14].

An entry was written by each author immediately after every Teams meeting. This was done in order to minimize the influence on each others opinions.

A template was used for the entries, seen in Figure 1. Inspiration was taken from [15], where they divided the template into different categories. A checklist was also used to make the author think about which areas were covered in an entry. Furthermore, the checklist was also used as a guideline in order to ensure that specific areas were reflected upon.

| **Checklist** | **Notes** |
|---|---|
| ☐ Description of events<br>☐ Influencing factors<br>☐ Yield<br>Reflections on technique<br>☐ Improvements<br>☐ Problems<br>☐ Good points<br>Reflections on performance<br>☐ Improvements<br>☐ Problems<br>☐ Good points | [Notes about anything]<br>**Reflections on technique**<br>[Notes about reflections on technique]<br>**Reflections on performance**<br>[Notes about reflections on performance] |

**Figure 1:** Template for autoethnography entries.

#### Customer feedback sessions

Information from the customers were gathered through a qualitative approach, that makes use of semi-structured interviews [16]. This gives the authors the opportunity to ask follow-up questions in order to capture thoughts that lies outside the scripted questions. The term Customer Feedback (CF) session was used in order to have a differentiation from the interviews requirements elicitation technique. CF sessions were used in every phase except introduction. They were conducted at the end of each Teams meeting together with the customers. Each session was recorded with the permission from each customer.

During the CF sessions, one author would be the interviewer and the rest were observers. The interviewer and the customer would have their cameras on while

the observers would have theirs off.

An overview of all the CF sessions can be seen in Table 6, where the length and participant for each CF session are shown.

| ID | Date | Customer | Time - mm |
|---|---|---|---|
| I1 | 05-10-2022 | PL | 03 |
| I2 | 10-10-2022 | SE-1 | 02 |
| I3 | 12-10-2022 | SE-2 | 03 |
| I4 | 17-10-2022 | SE-3 | 06 |
| I5 | 17-10-2022 | SP | 06 |
| I6 | 17-10-2022 | SE-4 | 02 |
| P1 | 08-11-2022 | SE-5 | 13 |
| P2 | 11-11-2022 | SE-4 | 11 |
| P3 | 15-11-2022 | SE-3 | 27 |
| P4 | 17-11-2022 | SE-2 | 10 |
| P5 | 22-11-2022 | TC | 21 |
| P6 | 23-11-2022 | TM | 24 |
| P7 | 24-11-2022 | PL | 19 |
| R1 | 12-12-2022 | TM | 44 |

**Table 6:** Overview of the CF sessions. The identifiers are used to reference each meeting in the results section.

Throughout the study the interview guide for the CF sessions developed, as more information was gathered from the customers. This is also one of the reasons why the CF sessions in the interviews phase were considerably shorter, because the questions lacked depth, resulting in brief responses from the customers.

### Data analysis

This section covers the data analysis of the recordings from the CF sessions and the entries from the autoethnography.

#### Transcription of the recordings

All the recordings of the CF sessions were transcribed. Descriptions of tone of voice, intonations, and breathing were left out, as well as details surrounding body language, posture, and gestures. Additionally, non-words like 'uh' or 'uhm' were also excluded. This means that the transcriptions are seen as decontextualized translations [16].

#### Coding

Coding was used in order to analyze the contents of the CF sessions and the autoethnography entries. The analysis was conducted using open- and axial coding described by Strauss and Corbin [17].

Open coding was done using a program called NVivo [18], that provided the functionality to fracture the texts into smaller sections and then provide each section with a label that described its content. The open coding for the CF sessions and autoethnography entries were done separately by two different authors.

After the open coding was finished, all the labels were set up on two separate digital whiteboards in a program called Padlet [19]. Here, axial coding was used in order to group the labels into categories, where the objective was to sort each label into a single category. Each label was reconsidered by all the authors in order to validate that the open coding had been done properly, ensuring that specific quotes fit into a given category. This process was done through multiple iterations, where categories were combined, added, or removed.

## IV. Results

The analysis of the statements from the CF sessions and the autoethnography entries resulted in a total of 8 categories. These categories are shown in Table 7, where a '✓' marks if a category is from the autoethnography, the CF sessions, or both. The results presented in this section were first introduced in a report written in the first half of the authors' master thesis project [20].

| Category | Autoethnography | CF sessions |
|---|---|---|
| Interviews | ✓ | ✓ |
| Prototyping | ✓ | ✓ |
| Screen-sharing | ✓ | ✓ |
| Scenarios | | ✓ |
| Think aloud | ✓ | ✓ |
| Observation | | ✓ |
| Experience with online meetings | | ✓ |
| Setup for Meetings | ✓ | ✓ |

**Table 7:** Categories gathered from the analysis of the statements from the CF sessions and autoethnopgrahy entries.

Each category is presented below, detailing important aspects mentioned by both the developers and the customers. Quotes from the developers are identified with 'D' followed by a number e.g. 'D2'. Quotes from the customers are identified by the job position followed with the ID for the CF session e.g. 'PL (I1)'. An overview of the CF sessions can be found in Table 6.

### Interviews

This category presents the thoughts about the activity semi-structured interviews and the usage of the interviews requirements elicitation technique. Overall, all the 6 customers, who participated in this activity were positive about the experience and the questions that were asked.

*"I actually think it went well (...) it wasn't a problem that it was on Teams (...)"* - PL (I1)

It was also a positive experience for the developers as the information gathered felt relevant.

For the interviews the questions were sent in advance. This was appreciated by the customers as it gave them the possibility to prepare beforehand.

*"I thought it was really nice, then you had the opportunity to know what you are asking questions about. At the same time I didn't choose to gather more information about things I didn't know about and didn't have answers to. I chose to say that it's better that you ask the ones who knows more. I thought it was nice to know which direction the interview went."* - PL (I1)

In total 5 out of the 6 customers read through the questions before an interview.

### Prototyping

This section presents the thoughts about the usage of the prototyping requirements elicitation technique. All the 7 customers who participated in the activities utilizing this technique were positive about the experience.

*"I thought it went well, prepared and all, so that's nice. You know what you want to talk about and ask about. It all runs smoothly, which is nice"* - SE-3 (P3)

The 3 developers were also positive about using the prototyping technique and thought that it produced more concrete information compared to the interviews technique.

*"It was generally much more concrete feedback, when they had an example to start from. In relation to the interviews we held earlier."* - D2

The customers were sent videos that give a short presentation of the prototypes before the meetings. 5 out of the 7 customers looked through the videos and 1 customer only skimmed them. These 6 customers thought it was a good idea to be sent the videos as preparation for the meetings.

*"It was really nice to get an understanding of it, what the meaning is or where you want to go with it. So I think it was nice, really nice."* - SE-5 (P1)

This approach was also positive for the developers, as there was a feeling that the customers were better prepared.

*"The fact that he had seen a video about the design beforehand seemed to make him know more about what it was all about. So overall, I think that it reduces the time spent on giving an explanation of things."* - D1

Different design alternatives were shown of the prototypes. This was received positively by the customers and it was even stated that the developers should create alternatives instead of letting the customers think of new ideas because the developers have more knowledge about design possibilities.

*"Yes, it's better that you create some alternatives, since you know more about it than the rest of us. Then it can give us an idea of what it could look like."* - SE-5 (P1)

Using different design alternatives was also seen as a positive approach by the developers.

*"The fact that we had made alternatives to some of the parts in the prototype also made him more willing to share his opinion about what he thinks was the best solution for him."* - D1

One developer noticed that the customers were more willing to state their opinions when different design alternatives were showcased.

### Screen-sharing

Screen-sharing was used through Teams when utilizing the techniques prototyping, think aloud, and scenarios. The customers felt that it was a positive experience when applying this technology. However, 4 out of 7 customers thought that the content on the screen was sometimes difficult to see. This could either be smaller texts, or pop-ups in Teams disturbing the view. One of the developers also encountered the problem with the smaller texts.

*"(...) the text on the website was a bit small, which meant that I needed to read out loud what was written. Here, you could look at methods that lets you zoom in on the prototype."* - D1

The customers' general opinion on screen-sharing was that it helps to communicate things visually.

*"It makes it a lot easier. When someone says "second column two down" and you are still unsure where it is. Then it's better to be able to show where it is with a mouse cursor."* - TC (P5)

### Scenarios

It was chosen to not utilize the scenarios technique during the activities. Instead the four SEs were shown a use case during the CF sessions. They all agreed the use case would not help them understand the design shown in the prototypes.

*"No, I think it makes it more complicated to look at a use case"* - SE-2 (P4)

From this feedback, it was further emphasized for the developers that not using the scenarios technique was the correct choice.

### Think aloud

The think aloud technique was utilized together with 3 SEs in order to encourage them to state their opinions about the design alternatives in the prototypes. All the SEs were positive about the technique, helping them confirm their first assumption about a design alternative.

*"I did confirm that alternative number 3 is more of a hassle than the others."* - SE-2 (P4)

One SE also mentioned that it was a good way to test out different navigation paths in the prototype.

*"I think it gives a good overview (...) It's a good solution to be allowed to go through it, then you also find out if it's a good solution or it's better to go the other way around"* - SE-3 (P3)

For this technique, it was arranged to have the customers take control of the cursor in order to make them interact with the prototypes themselves. However, due to security settings in Teams from the university, this was not possible. Instead, it was decided to have the customers direct the developer by telling them where to click in the prototype. One developer thought that by using this approach some of the intended value was lost.

*"This made the think aloud method lose a bit of its value."* - D1

The approach on how to use the technique was also discussed between all the authors. This let to the decision of continuing with letting the customers direct the developer, as all the authors thought that the outcome of the technique remained the same.

### Observation

In the last CF session, the TM was asked to reflect about the whole collaboration and the usage of observation techniques. Here, the developers and the TM agreed that some aspects of the daily tasks has been missed throughout the collaboration.

*"Yes I definitely think, with your outside perspective, if you had been a fly on the wall in the PLs office, and seen how they do this and that. Then they move their mouse over a thing 5 times, or they can't find the mail, now there's a person that got there late. Then that could make you guys say "Hey, we'll fix that just like that", and we wouldn't detect it ourselves."* - TM (R1)

The TM proposed a way for the developers to observe the daily work, when working in a remote environment.

*"(...) you could in principle have been remote and shared screens with the PL for a whole day. (...)"* - TM (R1)

It was also mentioned by the TM, that the behavior of the people being observed could change. Therefore, the TM suggested that objective data could also have been used.

*"(...) Could there be some more objective data. That could give input. How many of this type of email gets deleted, or how many cancellations are there."* - TM (R1)

### Experience with online meetings

The experience of using online meetings was varied between the customers. The TM had the most experience having used online meetings for multiple years. The PL and TC first began using online meetings at the start of the COVID-19 pandemic. For the SEs the experience was also varied, SE-2 had 2 years, SE-3 had 1 year, SE-5 a couple of months, and SE-4 used online meetings for the first time during the collaboration.

In the last CF session, the TM was asked, whether they thought that using online meetings in the collaboration had any implications.

*"No, but that is definitely in the context of it being used widely in the last year. I wonder how your project would have been if there hadn't been Corona. Maybe you should be really happy that there had been Corona, because now everyone is used to it. In the beginning there wasn't a big routine around it."* - TM (R1)

The authors reflected upon this quote, and also saw it as a consideration, as online meetings have been used more widely in the daily routines during the COVID-19 lockdowns, where you could also see acquaintances getting more accustomed to using online meetings.

### Setup for meetings

This section outlines the thoughts concerning the setup of all the meetings in the collaboration.

Technical problems were experienced in the online meetings, which were recorded by one of the developers in all phases except introduction. Table 8 presents how many meetings had technical problems.

| Phase | Had problems | Total |
|---|---|---|
| Interviews | 3 | 6 |
| Prototyping | 2 | 7 |
| Requirements | 0 | 1 |

**Table 8:** Number of technical problems encountered in the different phases, with the number of meetings which had problems and the total number of meetings.

A total of 5 meetings had technical problems, however, they were all fixed during the meetings. The problems ranged from connection issues to not being able to turn on the camera or microphone.

*"There were some technical problems since they were not allowed to share the camera over Teams in the browser. However, they solved it by installing Teams on the computer."* - D1

Comfort was also an important factor in the meetings. This was noticed during a meeting where the customer conducted the meeting through their phone, which could lead to fatigue due to holding the phone for a longer time.

*"He could get more tired of the interview if it took any longer, as he was not sitting very comfortably and he had to hold the phone."* - D1

In the meetings it was decided that everyone who spoke would have their cameras on, which was also well received by the customers.

*"Generally, I think it's really nice to see people when you talk to them, unless it's just a message."* - PL (P7)

In the meetings where the requirements elicitation techniques were utilized, two of the developers acted as observers. When using the interviews requirements elicitation technique it was tried to have observers turn their cameras turned on in two meetings. Here, the customers SE-1 and SE-4 said they had no problems being able to see the observers.

The customers also had no problems in the meetings where the observers had their cameras turned off. Here, a factor could have been that the observers presented themselves with the cameras turned on in the start of each meeting.

*"If you didn't know what it was all about and people just suddenly turned off so you couldn't see them, that would have been uncomfortable."* - SE-3 (I4)

In 5 occurrences, the customers said they forgot the presence of the observers when their cameras were turned off.

*"It was first when she said, "she needed to hear if you had any questions", that oh yes, someone is listening along. I didn't think about it that much."* - SE-2 (P3)

It was also stated by one developer that when the observers turned their cameras off, it felt like a one-on-one conversation.

*"The fact that the observers cameras were turned off also made it feel like the interview was more one-on-one. I don't think this could have been reproduced as easily in a physical setting."* - D1

When this quote was mentioned for the other authors, there was agreement on having the observers' cameras turned off, as the focus should only be on the participants that spoke in the meeting.

## V. Discussion

In this section, there will be a discussion of the successes and challenges discovered throughout this study when using remote requirements elicitation. It will also incorporate related work in order to make comparisons to existing findings.

### Successes

This section will elaborate on the successes encountered throughout the collaboration. The first three successes are not exclusive to the remote environment, but are still important considerations.

#### Selection of techniques

It is important to select the right techniques for the requirements elicitation activity. In this collaboration there was selected the techniques interviews, prototyping, and think aloud, which the customers were positive about. Furthermore, the authors preferred the prototyping technique compared to the interviews technique, as they felt it produced more concrete information.

The selection of interviews and prototyping can be set in relation to existing literature, which has found them to be among the most effective in a remote environment based on customer satisfaction [6], thereby, explaining the positivity received from the customers.

It was also the correct choice by the authors to not use the scenarios technique, as the customers found no benefit in using this technique. Instead, the prototyping technique was preferred by the customers. From the existing literature is was said that the scenarios technique was the second most effective based on customer satisfaction [6], which is seen as a contradiction to the findings in this paper.

#### Sending things beforehand

For the interviews technique, questions were sent beforehand to let the customers prepare for the meetings. This was well received, and it was pointed out by the customers, that it was nice to know what the developers wanted to gather information about.

When using the prototyping technique, videos were sent to all the customers beforehand, which gave a brief introduction to the contents of the prototypes. The customers were positive about this approach and the developers felt that the customers were better prepared, limiting the time used during the meetings explaining the prototypes.

#### Using design alternatives

While using the prototyping technique, different design alternatives were created in the prototypes. The developers noticed an increase in the customers' interaction in the design discussion when different alternatives were presented.

The design alternatives were further utilized while using the think aloud technique, where it helped the customers confirm, which alternative in the prototypes they preferred. It also provided the developers with information about which options the customers would choose when navigating through the prototypes, revealing where to improve or change the design.

#### No impact from observers

In all the meetings throughout the collaboration, the developers who were not the interviewer acted as observers. The observers had tried to have cameras on and off during the meetings, where the interviews technique was used. There was found no noticeable difference between the two approaches. The customers did not mind being able to see the observers, and when the cameras were off they would forget about their presence. This gives the developer the ability to choose the setup they prefer.

#### Setups for adaptation

For the interviews technique, regular Teams meetings were used where both the developer and the customer had their cameras on. Screen-sharing was added when using the prototyping technique and the think aloud technique, which allowed the developers to point at specific things in the prototypes. Overall, there was seen an immediate familiarity with the setups from both the developers and the customers, which made the utilization of the techniques much easier. There was also seen no difference with the familiarity when looking at the customers' experience with online meetings.

### Challenges

This section will detail the challenges encountered throughout the collaboration.

#### Using an online platform

The usage of an online platform can become a challenge if the customers have no prior experience using e.g. Teams or Zoom. However, one customer mentioned that after the COVID-19 pandemic these tools have become more commonplace, which is also backed up by the fact that all the customers except one had prior experience with the usage of Teams.

#### Technical problems

When using software tools, there is a possibility of encountering technical problems. This was also the case in the collaboration where a number of different problems arose, when using the interviews and prototyping technique. All the problems were fixed fairly quickly, however, if the customers had been harder to aid with technical support, this could escalate into a bigger challenge.

#### Security restrictions

When using the think aloud technique, the customers were meant to control the mouse cursor, but this was not possible due to security restrictions from the authors' university. The authors thought about other possibilities such as using private Teams accounts or utilizing Zoom. In the end, it was decided to let the customers direct the developer around in the prototypes, as the authors thought that the outcome remained the same for all these options. However, the restrictions for controlling the mouse cursor still has to be considered as it limits how different requirements elicitation techniques can be utilized in a remote environment.

#### Smaller texts in prototypes

Screen-sharing was used through Teams in the collaboration. Here, a problem concerning smaller texts in the prototypes was mentioned by both the developers and the customers. This problem was mainly caused from the usage of different monitor sizes. Later on in the collaboration it was found that Teams had a zooming feature, which minimized this problem. However, Figma did not have a zooming feature when presenting prototypes, which was thought to be the desired approach.

#### A need for observation

After the prototyping phase the developers felt that an observation technique could have clarified some uncertainties surrounding the customers' daily tasks. However, making an adaptation for observation techniques within remote requirements elicitation, is not as straightforward as e.g. using prototyping or interviews. Here, a more thorough thought process has to be conducted in order to find the right solution. In this collaboration the topic was discussed with the TM, where both concerns and potential solutions were presented, such as observing the customer through screen-sharing throughout a whole day. Alternatively, there could also be used recordings through either Teams or surveillance cameras.

#### Comfortability

Within an online meeting you need to be aware of the devices, which the participants are communicating through, such as a phone or a computer. This was noticed with a customer that participated in a meeting while holding their phone, as a longer meeting might introduce fatigue.

## VI. Conclusion

This paper presents the results of a case study, done in collaboration with a company that provides service of cranes in different sectors, investigating the successes and challenges developers have to consider when utilizing requirements elicitation techniques adapted to a remote environment. Five areas of successes have been presented, concerning the selection of the right techniques, sending things beforehand, using design alternatives, having observers, and the setups used for the adaptation of the techniques. Additionally, six categories of challenges were presented, concerning technical aspects, comfortability, and propositions for the usage of an observation technique.

The authors have used the selected requirements elicitation techniques in other university projects, but had

not used them outside this scope. This means that there might be common practices from software companies, regarding the requirements elicitation activity, that were unknown by the authors. However, this can also be a positive, as the authors have been unaffected by previous habits, and are more open for exploration. Furthermore, the results presented in this paper is from a single case study, which means it cannot be concluded whether the results are representative for other customers and developers.

In future studies, it would be interesting to conduct an action research study with a software development company, to investigate the process of adapting requirements elicitation techniques to a remote environment, in order to build upon the results gathered in this study.

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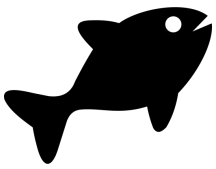
# Part III

# Article 3 - Experiment



# Remote Requirements Elicitation: Writing User Stories in Collaboration with a Customer

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**Abstract**

After COVID-19 working from home has become more common for developers, making it important to investigate how developers best work in this setting. Specifically, when communicating with customers in order to do requirements elicitation. This paper reports on an experiment studying the effect of visual presentations and different types of communication forms in remote requirements elicitation, between customers and developers. It involved 18 participants acting as developers that wrote user stories based on the same case. A modified INVEST grid has been utilized to evaluate the quality of the user stories. The results showed that utilizing video presentation together with online meetings produced user stories of better quality and increased communication with the customer.

**Author Keywords**

Experiment; Remote requirements elicitation; User stories; Online meeting, Instant messaging; Photo; Video

## I. Introduction

The amount of developers that are working remote is on the rise. Stack Overflow do yearly surveys, in 2019 12% reported to be working fully remote [1], while in 2022 the number is up to almost 43% [2]. However, it should be noted that the number can be affected by the fact that not all countries are over the lockdowns due to the COVID-19 pandemic.

Based on this upward trend in working remotely, it is important to research how developers work best in this setting. It is especially relevant to research how to effectively do requirements elicitation in this remote environment, where a developer is geographically separated from a customer, as requirements elicitation can determine the outcome of the software product.

Requirements elicitation can be done in a number of different ways, however, user stories is seen as an important software engineering tool in Scrum [3], and have been found to be one of the most successful agile methods in a literature review on agile practices in global software development [4]. At the time of writing no papers regarding requirements elicitation using user stories in a remote environment were found. However, there has been investigated the usage of different requirements elicitation techniques in a remote environment, where a proposition was made to use observation techniques to help in understanding the customer's needs [5]. Observation can be difficult to utilize in a remote environment and it is even stated that observation cannot be used in this setting [6, 7]. There is a need to research alternative techniques to observation in a remote environment. This can be done by finding other ways to visualize the customer's needs, that is used when developers are writing user stories.

The visualization can be done through different approaches. One of these is utilizing video through remote communication mediums e.g. taking inspiration from video ethnography where documentation is done through video footage that offers a way to understand the participants' perspectives [8]. Another approach is using photos, e.g. photo elicitation where photos are utilized in research interviews as part of empirical studies to increase the amount of information gathered from the subjects [9].

Visualization is not the only factor when finding out a customer's needs, communication is also important. There are different ways of communicating remotely. A developer can ask questions to a customer through instant messaging where text-based communication is used. Another method, is online meetings where you can see the customer's face through a web-cam and communicate verbally.

This paper reports from an experiment that have investigated the effect of using different types of visual presentations and communication forms, when writing user stories in a remote environment.

This research area is new and not well explored, therefore, an exploratory approach will be used for the methods utilized in the experiment.

In the following section related work will be presented along with the hypotheses of the study. This will be followed by method, results, and a discussion.

## II. Related Work & Hypotheses

This section will present results and theories from related work that shape the hypotheses of this paper.

### Visual presentation

The effect that visual elements have on remote requirements elicitation have not been widely explored before. This section will include different ways that video ethnography and photo elicitation have been used and what effect they have.

There are different ways to use video ethnography in a study. One paper utilized it by having participants in their study create video diaries [10]. The paper focused on reporting the method of using video diaries as a way to research the human body and the implications of using the method. The paper concludes that video diaries can be used to generate more detailed information that is often not a part of face-to-face and text-based approaches.

Another paper utilized video ethnography in a study where they were researching digital devices used in homes [11]. The study had originally planned to do in-person tours of people's homes, but were forced to find an alternative due to the COVID-19 pandemic. The paper focuses on the adaption made in order to continue the study remotely by using video ethnography to do home tours through Zoom. They found that the participants decided the scope of what is being recorded and viewed by the researchers. This means the researchers are limited in what the participants choose to show them. However, the participants can still be directed by the researchers through instructions.

The history as well as a definition of photo elicitation has been recorded in a paper [9]. It reports on a literature review that was done in order to find examples of when and how photo elicitation has been used. The paper states that photo elicitation is used to elicit more precise information by presenting photos to get more emotional responses out of participants, by bringing up memories associated with the photos.

Visual presentations can help the participant to be more descriptive. By providing developers visual presentations they might learn more about a new field of knowledge, which leads to the following hypothesis:

**H1:** Developers being shown visual presentations by customers, create higher quality user stories compared to being shown no visuals.

At the same time there might not be a difference between presenting a photo or a video to a developer.

**H2:** There is no difference between utilizing video or photo presentation, when it comes to the quality of the user stories.

Developers being shown visual presentations might understand what the customer wants or needs quicker, compared to being shown none.

**H3:** Developers being shown visual presentations by customers, makes the activity of creating user stories quicker compared to being shown no visuals.

Photo elicitation and video ethnography are both used to elicit more precise information, which means that developers might generally prefer being shown photos and videos, since it might make it easier to understand the customer.

**H4:** Developers will prefer being shown visual presentations compared to being shown no visuals.

### Communication

There are multiple studies that involve different requirements elicitation techniques, where the developer and customer communicate through text-based means. In an empirical study they compared text-based communication against in-person face-to-face meetings, when creating requirements [12]. The participants were students taking part in a requirements engineering course. They were allocated in groups that took turns acting as customers or developers. The goal for the students was to create a requirements specification document through requirements elicitation and negotiation. The study found that there is a general preference for in-person face-to-face meetings compared to text-based communication. The participants also evaluated their satisfaction with their own performance. Here, the participants were more satisfied when negotiating using face-to-face meetings. The paper did not make an evaluation of the requirements' quality. This means that a comparison between the participants' satisfaction with their own performance and the produced requirements have not been included.

Another paper reports on two experiments done in order to evaluate a new method based on think-pair-square for developers to create use cases remote [13]. Use cases are not the same as user stories, but can also be used to describe features. The first experiment used university students as participants. They were divided into two groups, one trying the new method face-to-face and the other in a remote environment. In the remote environment they utilized an application to show and create the use cases. The application also provided text-based communication. The second experiment was repeated with the same students in order to study what impact familiarity had on the method. The results showed no significant difference in the quality of the use cases between the two groups. However, in the experiment significantly less time was spent on creating the use cases face-to-face.

These two studies both indicate that text-based com-

munication with a customer is not preferred or better in quality compared to in-person face-to-face communication.

A comparison between text-based communication and verbal communication through an online meeting, will be made in this paper. Based on the related work, face-to-face communication is preferred and in this paper's experiment the verbal communication through an online meeting is closest to a face-to-face meeting, which has led to the following hypothesis:

**H5:** Developers prefer verbal communication through an online meeting compared to text-based communication.

Text-based communication brings natural barriers such as having to type out your questions, which can lead to less questions asked.

**H6:** Developers ask more questions through an online meeting compared to text-based communication.

## III. Method

This section describes the method used for the experiment in this paper. It includes six conditions, which are shown in Table 1. The independent variables, types of visual and types of communication, have been researched through a between-group experiment to avoid the learning effect in relation to the case. The participants have written user stories for a case during the experiment. The chosen case involved fish farming, as this area is not common knowledge for the participants. The case was about creating an application, that can help deciding which fish tanks fish should be transported to when they have outgrown their current tank. One author acted as the customer throughout the experiment.

| | | Types of communication | | |
|---|---|---|---|---|
| | | Instant messaging | Online meeting | **Total** |
| **Types of visual** | Video | VI (3) | VO (3) | **6** |
| | Photo | PI (3) | PO (3) | **6** |
| | None | NI (3) | NO (3) | **6** |
| | **Total** | **9** | **9** | |

**Table 1:** Overview of the conditions in the experiment together with the number of participants for each condition indicated in parenthesis.

### Types of visual

The type of visual that was used by the customer to showcase the problem was one of the independent variables in the experiment. Separate recordings were made for the video, photo, and none conditions that each used their visual features to present the case. The recordings contained the same information by having the customer read from the same script. The information was verified by the owners of the fish farm. Meaning, the only difference is the type of visual used. Alternatively, the visuals could have been shown through an online meeting, between the participant and the customer. However, this brought up questions of when to allow the participants to ask questions, and how to handle the instant messaging variable. Therefore, it was deemed that showing the visuals through a recording would be a more suitable approach.

#### Video

The participants in two of the conditions saw a recording, where the customer utilized video presentation to explain the problem. These conditions are denoted as VI and VO, where V stands for video. The recording was made by the customer at the fish farm, where a smartphone was used to capture the footage. The start of the recording showcased the customer's face, the rest showed the fish farm.

#### Photo

The participants in two of the conditions saw a recording, where the customer utilized photo presentation to explain the problem. These conditions are denoted as PI and PO, where P stands for photo. The recording was made using screen capture to show photos taken from the fish farm. The recording showed the photos along with the face of the customer.

#### None

The participants in two of the conditions saw a recording where the customer did not use any types of visual to explain the problem. These conditions are denoted as NI and NO, where N stands for none. The recording only showed the face of the customer.

### Types of communication

The type of communication was one of the independent variable in the experiment.

#### Instant messaging

The participants in three of the conditions could ask the customer questions through instant messaging in Teams after watching the recording. These conditions are denoted as VI, PI and NI, where I stands for instant.

#### Online meeting

The participants in three of the conditions could ask the customer questions through an online meeting in

Teams after watching the recording. These conditions are denoted as VO, PO and NO, where O stands for online.

### Participants

The participants in the experiment were graduate and under graduate students from the computer science and software engineering educations. There were 18 participants in total, 5 female and 13 male. The participants were randomly assigned a condition. However, counter balance was utilized in order to minimize gender as a confounding variable.

### Setting

The experiment was held in a group room at the university, where a computer with a headset was set up for the participant. The author acting as customer was geographically separated from the participant. The other two authors were experimenters, where one was the lead experimenter and interacted with the participant, while the other was assistant experimenter, who observed closely and helped during the experiment. The lead and assistant experimenter were in the group room, together with the participant.

### Procedure

Each experiment was done with one participant at a time. The experiment took at most one hour and were set up in 5 steps. An overview can be seen in Table 2, where the duration of each step is shown.

| Steps | Time (min) |
|---|---|
| Step 1: Introduction | 6 |
| Step 2: Watching recording | 12 |
| Step 3: Explanation for the next step | 2 |
| Step 4: Writing user stories | 30 |
| Step 5: Questionnaire | 10 |

**Table 2:** The different steps of the experiment procedure along with the amount of minutes each step takes.

#### Step 1: Introduction

The lead experimenter gave an introduction to the participant. After the introduction, the lead experimenter explained what user stories are and how the participant should write them by showcasing two examples. The lead experimenter also presented the criteria that describes a good user story. The criteria which are based on INVEST [14], that acts as a guideline through six different criteria named independent, negotiable, valuable, estimable, small, and testable.

#### Step 2: Watching recording

The participant was instructed to watch one of the recordings made by the customer. The recording was played from start to end without being paused. The type of visual presentation shown in the recording depended on which condition was assigned to the participant.

#### Step 3: Explanation for the next step

The lead experimenter instructed the participant to write the user stories in a template and presented what they could do in the next step:

- Replay the recording or parts of it.
- Ask questions to the customer.
- Write user stories into the template.
- Take notes with pen and paper.

At the end of the step, the assistant experimenter set up the communication with the customer through Teams with either instant messaging or an online meeting.

#### Step 4: Writing user stories

During this step the participant wrote user stories. They were given 30 minutes to write user stories to cover the case. They could stop if they felt they were done. The assistant experimenter informed the participant when there was 5 minutes left. The participant was stopped when 30 minutes had gone by.

#### Step 5: Questionnaire

At the end of the experiment the participant filled out a questionnaire. The participant answered questions regarding the type of communication and type of visual they were assigned. The participant could also express if they had any ideas on improvements for their condition.

### Materials

The materials used for each step are described in this section.

#### Step 1: Introduction

3 pieces of laminated paper were given to the participant during the introduction. The first one showcased the activities in the experiment along with an time estimate for each activity. The second depicted the template used for the user stories along with two examples. The third showed the criteria that describes a good user story.

The participant was also given a pen and paper, which they could freely use to take notes during the experiment.

#### Step 2: Watching recording

The participant saw a recording made by the customer, that presented the case, with the visual presentation

they were assigned. They were also given a piece of laminated paper that summarized this activity.

#### Step 3: Explanation for the next task

The participants were given a laminated piece of paper, that stated the four things they were allowed to do in the next step. The participants were also given a digital document with the template, that shows how the user stories should be written. The first part of the template is the user story (1), while the second part is the acceptance criteria (2) for the user story:

1. As a [role], I want [goal], so that [benefit]
2. Given [context], when [action], then [outcome]

By extending the content of the user stories to include acceptance criteria, it can minimize the chance that all participants write the same user stories. The acceptance criteria is used to validate that the functionality described in a user story has been implemented.

#### Step 4: Writing user stories

No new materials were introduced in step 4.

#### Step 5: Questionnaire

The participants were given a digital questionnaire on the computer to fill out.

### Data Collection

Table 3 gives an overview of the data collected throughout the experiment, which includes the type of data.

| Type | Data |
|---|---|
| min. | Time spent by the participant writing user stories. Taken with a digital stopwatch. |
| no. | Questions asked by the participant. Counted by going through each recording of the online meetings, and the history of the instant messages. |
| file | User stories written by the participants. |
| file | Questionnaire completed by the participants in SurveyXact [15]. |

**Table 3:** List of the data collected throughout the experiment.

The time was measured from the start of step 4 until the participant said that they were done or they reached the time limit of 30 minutes.

The questionnaire contained questions regarding a participant's background, e.g. gender and age. The questions also covered their experience with the assigned type of visual and communication. There were nine questions that could be answered through a five-point Likert scale. This was followed by a series of questions where the participant had room to write a free text, regarding their improvement ideas for the assigned type of visual and communication.

### Data analysis

This section describes the analysis of the data collected from the experiment.

#### Preparing user stories

All the user stories were inspected in order to filter out the ones that were not completely filled out. An example could be that the participant had filled out the user story part, but the acceptance criteria had been left blank, then the whole user story would be disregarded.

#### Evaluation of user stories

For the evaluation of the user stories, the INVEST model introduced by Wake has been used [14]. The model consists of 6 characteristics one for each letter in the acronym. This model only functions as a guideline for a good user story, defining no direct scoring system. The guideline has been made into an evaluation model by taking inspiration from an article that sets up criteria for each letter in the model, defined in an INVEST grid [16].

Each letter in the INVEST grid evaluates different aspects of quality in a user story, I (Independent) focuses on having the features in a software system divided through multiple user stories, to make it easier to schedule and implement features in any order. N (Negotiable) indicates that a user story should not be an explicit set of requirements, as this is done in the requirements specification. Instead, a good user story should contain enough information to be prioritized and scheduled. V (Valuable) states that the customer's needs should be in focus and a user story should capture the features requested by the customer. E (Estimable) highlights the importance of being able to understand a user story, and leaving no room for uncertainties, or else a user story cannot be prioritized and estimated properly. S (Small) describes the agile process, which a user story is part of, meaning a feature described in a user story should be able to be implemented in a limited time frame such as a Sprint. T (Testable) ensures that a customer should be able to validate the described feature in a user story.

A letter is scored on a scale from 0 to 3, where 3 is the best, meaning that one user story receives 6 scores, one for each letter. The grid has been further developed in this study through multiple iterations where a sample of the collected user stories was used to test the evaluation. The focus has been on making the evaluation intersubjective, meaning that there is a shared agreement for what each letter represent. Additionally, it should also be possible to evaluate each user story independently. The final version can be found in Appendix A.

Before using the model, a Minimal Viable Product (MVP) has to be defined. It is used for the letter I (Independent) to make it possible to evaluate each user story without having to consider any of the other user stories, which was a necessity in the criteria for I in the original INVEST grid. The MVP should consist of a collection of user stories, which describes the minimum amount of functionality necessary in the developed software system. The MVP used in this study has been validated by the owners of the fish farm in order to ensure a proper evaluation.

Another change that has been introduced in the grid, is the evaluation of the acceptance criteria for a user story. It has been defined that the acceptance criteria has to be considered for all letters except I. Furthermore, T (Testable) has been changed in order to ensure that the acceptance criteria covers the described functionality in the user story.

For the letter S (Small), there has been a focus on making the estimation of a user story more abstract. For this purpose, the t-shirt model [17] has been used going from a score of 3 (S) to 0 (XL), meaning that a user story scores higher, when it has been estimated to take less time to implement the described functionality.

Example user stories, which can be found in Appendix B, have also been created as guidelines for the letters S and E (Estimable), in order to make the scoring more intersubjective.

The user stories collected from the participants in the experiment were individually scored by the three authors in a random order. Afterwards, the averages for all the scores were calculated.

| Letter | Kappa score | Strength |
|---|---|---|
| I | 0.45 | Moderate |
| N | -0.01 | No agreement |
| V | 0.48 | Moderate |
| E | 0.14 | Slight |
| S | 0.12 | Slight |
| T | 0.18 | Slight |

**Table 4:** Kappa scores calculated for the inter-rater reliability between the authors from the evaluation of the user stories.

Inter-rater reliability was tested between the authors by using Fleiss's Kappa score [18]. An overview can be seen in Table 4 where each score has also been measured using strength of agreement defined by Landis and Koch [19].

#### Qualitative data

Qualitative data was collected from 3 questions in the questionnaire, where the participants could write a free text. The answers were analyzed using thematic analysis [20], starting with each author generating codes individually. Afterwards, all the authors searched for themes in collaboration by looking at all the codes, where themes could be discarded, merged or added throughout.

#### Quantitative data

The quantitative data consists of the scores for the user stories, the participant's time spent on writing user stories, number of questions asked by the participant, and the Likert scale questions in the questionnaire filled out by the participant. These data have been analyzed, using SPSS, by looking for significance in the results. A value of 0.05 has been set as the P value threshold [21].

To get an initial overview for any significance factors, a factorial ANOVA was used [21]. Afterwards, if there was found significance for any variables, an independent-samples t test was used when a grouping consisted of 2 different conditions [21], or a one-way ANOVA [21] when a grouping consisted of 3 or more conditions [21]. An example could be that for 'types of communication' the independent-samples t test would be used because there are two conditions namely 'instant messaging' and 'online meeting'.

## IV. Results

This section presents the findings from the analysis of the data collected from the experiment.

### Effect of visual presentation

One-way ANOVA tests were performed, in order to compare the effect of types of visual on the results for each letter in the INVEST evaluation. Outliers were removed before each calculation. Table 5 gives an overview of the results for each letter in INVEST.

| Letter | (BG) df | (WG) df | F | p |
|---|---|---|---|---|
| I | 2 | 79 | 1.921 | 0.153 |
| N | 2 | 91 | 0.740 | 0.480 |
| V | 2 | 89 | 7.421 | 0.001 |
| E | 2 | 91 | 2.226 | 0.114 |
| S | 2 | 91 | 1.618 | 0.204 |
| T | 2 | 91 | 3.861 | 0.025 |

**Table 5:** One-way ANOVA results for types of visual for each letter of the INVEST evaluation, where outliers were removed beforehand. BG stands for between groups and WG stands for within groups.

V (Valuable) and T (Testable) resulted in a statistically significant difference. Figure 1 provides an overview of the score each user story received on V pooled according to identical types of visual.

Figure 2 provides an overview of the score each user story received for T pooled according to identical types of visual.

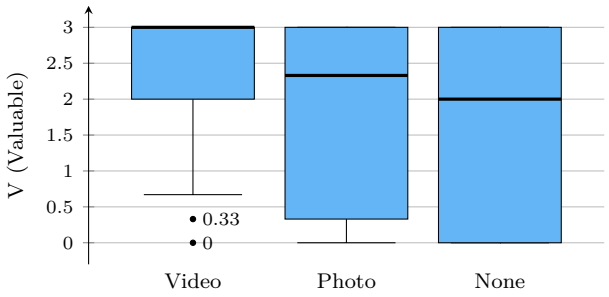


**Figure 1:** The score for V (Valuable) in INVEST in conditions pooled according to identical type of visual. The circle indicates outliers.

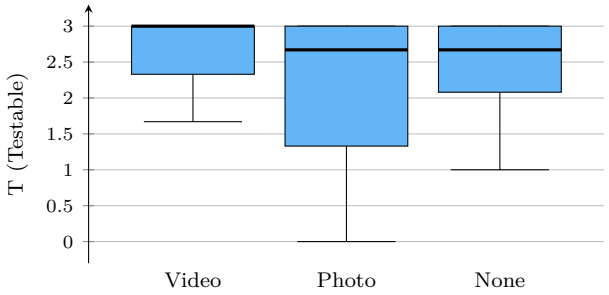


**Figure 2:** The score for T (Testable) in INVEST in conditions pooled according to identical type of visual.

| Letter | Group | M | SD | df | t | p |
|---|---|---|---|---|---|---|
| I | Video | 2.578 | 0.694 | 54 | -0.287 | 0.569 |
| | Photo | 2.628 | 0.606 | | | |
| N | Video | 2.586 | 0.433 | 61 | 1.167 | 0.401 |
| | Photo | 2.444 | 0.528 | | | |
| V | Video | 2.613 | 0.627 | 59 | 3.242 | <0.001 |
| | Photo | 1.822 | 1.199 | | | |
| E | Video | 2.404 | 0.491 | 61 | 2.004 | 0.047 |
| | Photo | 2.089 | 0.742 | | | |
| S | Video | 2.394 | 0.574 | 61 | 1.591 | 0.614 |
| | Photo | 2.144 | 0.671 | | | |
| T | Video | 2.707 | 0.439 | 61 | 2.558 | <0.001 |
| | Photo | 2.256 | 0.904 | | | |

**Table 6:** The table shows the results on an independent-samples t test for types of visualization, for the conditions video and photo presentation, for each letter of the INVEST evaluation. Outliers were removed beforehand.

Independent-samples t tests were performed to compare the effect of video and photo presentation results for each letter of the INVEST evaluation, outliers where removed before each calculation. Table 6 gives an overview of the results for each of the letters in INVEST. V (Valuable), T (Testable) and E (Estimable) all resulted in a statistically significant difference. Figure 3 provides an overview of the score each user story received for E pooled according to identical types of visual.

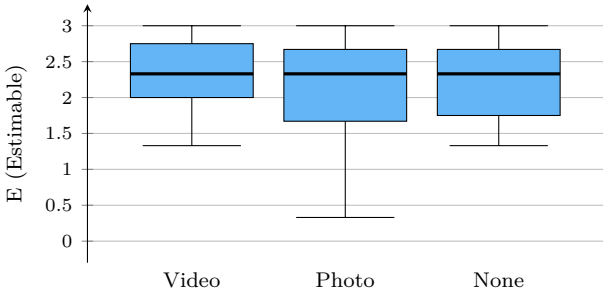


**Figure 3:** The score for E (Estimable) in INVEST in conditions pooled according to identical type of visual.

Figure 4 provides an overview of the time each participant spent creating user stories pooled according to the identical types of visual. With the two outliers removed, a one-way ANOVA was performed to compare the effect of types of visual on time spent creating user stories. A one-way ANOVA revealed that there was not a statistically significant difference in time spent creating user stories between at least two conditions ($F(2, 13) = 1.422$, $p = 0.276$).

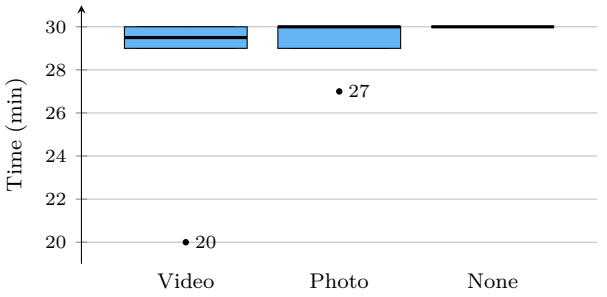


**Figure 4:** Time spent creating user stories per participant in conditions pooled according to identical type of visual. The circle indicates outliers.

| Question | (BG) df | (WG) df | F | p |
|---|---|---|---|---|
| Q4 | 2 | 15 | 0.246 | 0.785 |
| Q5 | 2 | 14 | 1.600 | 0.237 |
| Q6 | 2 | 14 | 2.907 | 0.088 |

**Table 7:** One-way ANOVA results for types of visual on answers from the questionnaire, outliers were removed beforehand. BG stands for between-group and WG stands for within-group.

Table 7 gives an overview of the results from the one-way ANOVA tests, that were performed to compare the effect of types of visual on the answers from question 4-6 in the questionnaire. Outliers were removed before each calculation.

Q4 asks the participants if the case was presented in a good way in the recording. Q5 asks about how good an understanding they had of the case. Q6 asks about whether they felt it was necessary to ask the customer questions. None of the results revealed a statistically significant difference. Through thematic analysis one theme was found concerning the effect of visual presentation. The theme was found in the answers to question 11 of the questionnaire, that asked the participants to write suggestions on how the case could be presented better by the customer. The name of the theme was 'better presentation structure', where 9 out of 18 participants suggested that a better presentation structure could have helped in the presentation of the case. A majority of the 9 participants suggested that slides, showing pictures accompanied by words, should be used as the presentation format for the case.

### Effect of communication

Independent-samples t test was performed in order to compare the effect of types of communication on the answers from question 1-3 in the questionnaire. Table 8 gives an overview of the results for each of the questions. Q1 asks the participant if the communication type was good. Q2 asks if they found it easy to ask questions. Q3 asks whether they felt they got their questions answered. For Q3 the participants that did not ask any questions were filtered out, and outliers were removed before each calculation. None of the results revealed a statistically significant difference.

| Question | Group | M | SD | df | t | p |
|---|---|---|---|---|---|---|
| Q1 | I | 3.44 | 1.014 | 15 | -2.407 | 0.319 |
| | O | 4.50 | 0.756 | | | |
| Q2 | I | 3.56 | 1.024 | 16 | -0.647 | 0.447 |
| | O | 3.89 | 1.167 | | | |
| Q3 | I | 5 | 0 | 8 | 0.632 | 0.168 |
| | O | 4.86 | 0.378 | | | |

**Table 8:** 'I' stands for instant messaging and 'O' stands for online meeting, outliers were removed beforehand. The table shows the results from an independent-samples t test for types of communication on answers from the questionnaire.

Figure 5 provides an overview of the number of questions each participant asked, pooled according to the identical types of communication. An independent-samples t test was performed in order to compare the number of questions asked between the two conditions instant messaging and online meeting. There was found a significant difference between instant messaging (M = 0.67, SD = 1) and online meeting (M = 9.46, SD = 9.748); t(16) = -2.721, p = <0.001.

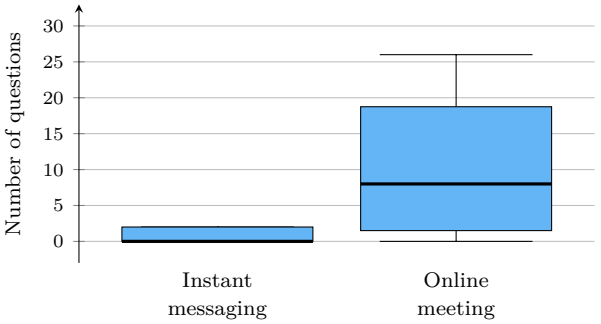


**Figure 5:** Number of questions asked by each participant pooled according to identical type of communication.

Through thematic analysis one theme was found concerning the effect of communication. The theme named 'wish for online meeting' was found in the answers to question 12 from the questionnaire, that asked the participants to write suggestions on how to improve communication with the customer. In the instant messaging condition, 5 out of 9 of the participants suggested that communication could be improved through an online meeting.

## V. Discussion

This section will discuss the findings in relation to the six hypotheses and make comparisons to related work. It will also include a discussion about the evaluation process of the user stories.

### Visual presentation hypotheses

**H1:** Developers being shown visual presentations by customers, create higher quality user stories compared to being shown no visuals.

From pooling the user stories according to the identical types of visual, it was found that V (Valuable) and T (Testable) in the INVEST evaluation both had statistical significance differences. It can be seen on Figure 1 that video and photo presentation both have a higher median, when it comes to V, compared to the none condition. For T it can be seen on Figure 2 that the median for video presentation is higher than photo presentation and none, while photo presentation and none are equal. Based on these observations H1 has been accepted. Two studies showed that using video and photo presentation resulted in eliciting more detailed information [9, 10]. More detailed information may have had an impact on the knowledge sharing between developer and customer in this experiment leading to user stories with a better quality.

**H2:** There is no difference between utilizing video or photo presentation, when it comes to the quality of the user stories.

Comparing the quality between the user stories in the video and photo conditions showed a statistically significant difference for V (Valuable), E (Estimable) and T (Testable) in the INVEST evaluation. It can be seen on Figure 1 that video presentation has a higher median than photo presentation for V, meaning it scores higher. In Figure 2 it can be seen that for T, video presentation has a higher median than photo presentation. For E it can be seen in Figure 3, that video and photo presentation has the same median, however, the range of the score for video presentation is smaller and leaning towards a higher score than photo presentation. Based on these observations H2 has been rejected, as there is a difference in the quality between the two visual presentations.

**H3:** Developers being shown visual presentations by customers, makes the activity of creating user stories quicker compared to being shown no visuals.

There was found no statistical significant difference in the time it took the participants to create their user stories, when pooling the participants according to the identical types of visual. Based on this observation H3 has been rejected. However, the setup of the experiment might not have been an ideal environment to answer this hypothesis, as 13 participants used up all the time and 4 where done a few minutes before the time was up, as can be seen in Figure 4. This indicates that a majority of the participants were cut off before they were done creating user stories. The time restriction of 30 minutes was originally set in order to keep the experiment under one hour to attract more participants for the study. An alternative could be to let the participants write user stories until they have covered the case. However, this would make it harder to schedule the experiments, as participants would use different amounts of time to finish writing user stories.

**H4:** Developers will prefer being shown visual presentations compared to being shown no visuals.

Question 4, 5, and 6 in the questionnaire were designed in order to capture the participants' preference for their assigned visual presentation. There was found no statistically significant difference in the results for these questions as shown in Table 7. Based on this H4 is rejected. However, there was found the 'better presentation structure' theme through thematic analysis, where a majority of the participants suggested that slides, showing pictures accompanied by words, should be used as the visual presentation form. This indicates that slides could be the preferred approach.

**Communication hypotheses**

**H5:** Developers prefer verbal communication through an online meeting compared to text-based communication.

Question 1, 2, and 3 in the questionnaire were designed to capture the participants preference for the assigned communication type. There was found no statistically significant difference in the results for these questions as shown in Table 8. Based on this H5 is rejected. A theme was found through a thematic analysis called 'wish for online meeting'. The theme is based on 5 out of the 9 participants in the instant messaging condition suggesting that communication could be improved through an online meeting. This cannot be seen as conclusive, but more as an indicator that verbal communication could be preferred over text-based. One study found that participants preferred face-to-face meetings compared to text-based communication [12]. This is not directly transferable to the results in this study, however, it can indicate that online meetings are preferred as they also use verbal communication.

**H6:** Developers ask more questions through an online meeting compared to text-based communication.

Comparing the number of questions participants asked in the instant messaging and online meeting conditions showed a statistically significant difference. It can be seen in Figure 5 that the median for online meeting is higher than the median for instant messaging. Based on this observation H6 is accepted. This result corresponds with the 'wish for online meeting' theme, and can be seen as an indication that the participants finds it easier to communicate verbally through an online meeting.

**Evaluation of user stories**

This section will discuss the INVEST grid used to evaluate the quality of the user stories.

The inter-rater reliability scores for each letter in INVEST were different, as seen in Table 4. The I (Independent) and V (Valuable) kappa scores were higher than the other letters. N (Negotiable) had the lowest kappa score, with a strength of no agreement. The score of N is decided by the amount of explicit functionality descriptions a user story contains. There might have been different understandings of what 'explicit' implies between the authors. This could indicate that the INVEST grid should be improved in order to better describe N, and maybe user story examples should have been made for the letter.

The low inter-rater reliability scores between the authors could also indicate that utilizing the INVEST grid might not be the best way to evaluate the quality of user stories in a intersubjective manner. Instead of giving user stories multiple scores, another approach could have been to simplify the process. This could be

achieved by giving a single rating on a scale from 1 to 5, where a score of 5 is given to a good quality user story and 1 is given to a user story of poor quality. The problem with this approach would be to capture all the quality aspects of a user story on a single scale. This means further investigation into the subject of evaluating user stories is needed.

## VI. Conclusion

This paper presents the results of an experiment done in order to research the effect of different visual presentations and communication forms when writing user stories in the context of remote requirements elicitation. Video and photo presentation were used as visual presentations and were compared to being shown none. Instant messaging and online meetings were used as the communication forms.

The results show that the quality of the user stories created in the experiment increased when the customer utilized video and photo presentation to explain the case to the participants. When comparing the quality between the usage of video and photo presentation, it was found that video presentation produced the highest quality. The participants did not show any preference between the visual presentations. However, a theme was found regarding participants that wanted better presentation structure in the form of slides. Another theme was found for the participants that communicated with the customer through instant messaging. It indicated that there was a wish to communicate through online meetings instead. Furthermore, the participants who communicated through online meetings asked more questions.

From the results it can be seen that utilizing video presentation together with an online meeting produced the best quality when creating user stories and increased communication with the customer.

The results are limited by the amount of time given to the participants for writing user stories, as most were cut-off before they were done, which may have an impact on the quality of the user stories. It is also limited by using an author as the customer, as the author has stake in the results of the experiment.

In the future it would be relevant to conduct similar experiments on other alternatives to the observation technique, such as using slides as a visual presentation. An experiment with more time or a smaller case could also be interesting to limit the impact of the time restriction. It would also be interesting to do action research where the visual presentation with the best quality would be introduced to a developer team, in order to observe the usage in practice.


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## Appendix A - INVEST Grid

| INVEST | Description | 0 | 1 | 2 | 3 |
|---|---|---|---|---|---|
| I (Independent)<br><br>(User story) | User stories should be as independent as possible | The user story covers more than three of the defined user stories in MVP or it covers more than two user stories in the MVP and describes functionality outside the scope of the MVP | The user story covers three of the defined user stories in MVP or it covers two user stories in the MVP and describes functionality outside the scope of the MVP | The user story covers two of the defined user stories in MVP or it covers one user story in the MVP and describes functionality outside the scope of the MVP | The user story covers none or a single user story defined in the MVP |
| N (Negotiable)<br><br>(User story & acceptance criteria) | User stories should leave room for negotiation with the customer | The user story contains only explicit described functionality | The user story contains over 50% explicit described functionality | The user story contains under 50% explicit described functionality | The user story contains no explicit described functionality |
| V (Valuable)<br><br>(User story & acceptance criteria) | User stories should provide value to the customers in terms of the solution | The user story does not describe any functionalities requested by the customer or the functionalities are not relevant to be implemented in a software system | The user story contains over 50% described functionality not requested by the customer | The user story contains under 50% described functionality not requested by the customer | The user story only contains functionality requested by the customer |
| E (Estimable)<br><br>(User story & acceptance criteria) | Each user story must be able to be estimated in terms of relative size and effort | The user story cannot be understood or there are uncertainties for all the described functionality, thereby, making it inestimable | The user story can be understood, but there are uncertainties for over 50% of the described functionality | The user story can be understood, but there are uncertainties for 50% or less of the described functionality | The user story can be understood and there are no uncertainties about the described functionality |
| S (Small)<br><br>(User story & acceptance criteria) | Each user story should be able to be completed within a Sprint while leaving space for other user stories to be completed | The size of the user story is defined as XL using the t-shirt method | The size of the user story is defined as L using the t-shirt method | The size of the user story is defined as M using the t-shirt method | The size of the user story is defined as S using the t-shirt method |
| T (Testable)<br><br>(User story & acceptance criteria) | Each user story should contain an acceptance criteria that covers the described functionality in the user story | The acceptance criteria does not cover the described functionality in the user story | The acceptance criteria covers under 50% of the functionality described in the user story | The acceptance criteria covers over 50% of the functionality described in the user story | The acceptance covers all the functionality described in the user story |

**Table 9:** INVEST grid. For all letters except I the acceptance criteria has to be considered, this is shown below each letter in the 'INVEST' column. The scores ranges from 0 to 3, where 3 is the highest score.

## Appendix B - User Stories Examples for INVEST Grid

| INVEST | Description | 0 | 1 | 2 | 3 |
|---|---|---|---|---|---|
| E (Estimable) | Each user story must be able to be estimated in terms of relative size and effort | As a worker, I want to be supported in my daily tasks by a software system, to easen my work burden | As a worker, I want to be supported by a software system when moving fish, to easen my work burden | As a worker, I want to be told where to move the fish by the software system, to let the fish grow | As a worker, I want the system to tell me which fiberglass basins should be used when moving eggs from the brood, to let the fingerlings grow |
| S (Small) | Each user story should be able to be completed within a Sprint while leaving space for other user stories to be completed | As a worker, I want to be able to get an overview of all the basins, where it should be possible to see and enter details about a selected basin to document and support my daily tasks | As a worker, I want to be able to see and enter details about a basin, to document and support my daily tasks | As a worker, I want to be able to enter details about a basin, to document my daily tasks | As a worker, I want to be able to enter weight details about a basin, to document the weight of a batch |

**Table 10:** User stories examples for the score ranges for E (Estimable) and S (Small) in the INVEST grid.