Defining a Method for Recognizing and Discussing Ethical Dilemmas during Requirements Elicitation

Master thesis Business Informatics

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Abstract

In this day and age where software and humans are increasingly intertwined with one another, requirements engineering has a more direct impact on human lives than ever before. This development raises ethical dilemmas when eliciting these requirements. Consequently, recent literature on requirements elicitation stresses the need to incorporate ethical considerations into this process of elicitation.

The intent of this research is to investigate how ethical considerations can be incorporated systematically into the requirements engineering so possible ethical dilemmas can be tackled from the beginning of software development. Therefore, the research goal is creating a method that supports in recognizing, and discussing, ethical dilemmas during the requirements elicitation process.

This research proposes a 5-step method to answer this research goal. The method consists of the following steps: Elicitate requirements, Identify the requirements where ethical dilemmas could occur, Discuss the ethical dilemmas, Storing the ethical dilemmas and 5. Solving the ethical dilemmas. By adhering to this method, ethical dilemmas are recognized at the beginning of a software project, subsequently be tackled, and solved.

Validations, by means of a case study and expert interviews, show a strong support of this novel method by praising its effectiveness and ease of use. This research paves the way for further incorporation of ethics into requirements elicitation by providing a foundation on which to work from.

Keywords: ethical dilemmas, ethical reasoning, requirements engineering, requirements elicitation.

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1 Introduction

In the extensive field of requirements engineering, which is defined as '*a coordinated set of activities for exploring, evaluating, documenting, consolidating, revising and adapting the objectives, capabilities, qualities, constraints and assumptions that the system-to-be should meet based on problems raised by the system-as-is and opportunities provided by new technologies*' (Van Lamsweerde, 2009), a plethora of research has been conducted since the first introduction of the term requirements engineering in the 1960s (Dresner & Borchers, 1964). The goal of requirements engineering is to produce a set of system requirements which is complete, consistent, relevant and reflects what the customer actually wants (Sommerville & Sawyer, 1997). Therefore, is it paramount to fully understand and define what exact problem needs to be solved. This is done by stating *what* the problem should solve, *why* this problem needs to be solved and *who* should be involved in solving the problem (Van Lamsweerde, 2009). Unlike software engineering, which is solely concerned with machine phenomena, requirements engineering is concerned with the machine's effect on the surrounding real world and assumptions made about that world. It is solely concerned with world phenomena, including shared ones (Van Lamsweerde, 2009). A visualization showing the focus area of requirements engineering, the area marked in grey, can be seen below in figure 1. The white area is the focus area of software engineering.

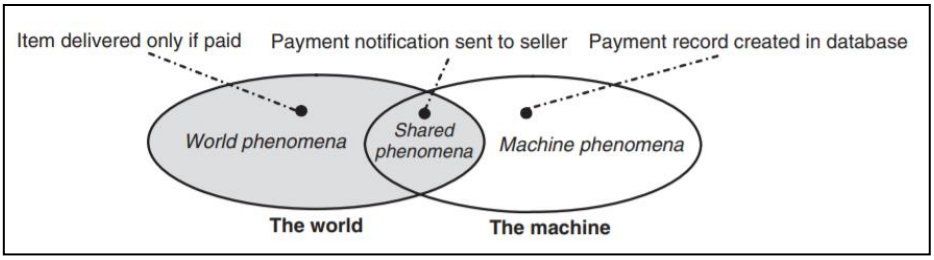

Figure 1. The problem world and the machine solution (Van Lamsweerde, 2009).

1.1 Problem statement

If requirements engineering is not done correctly, numerous problems can occur, such as missing functionality due to having no specific requirements on that particular function or incorrectly working functionality due to having the wrong requirements. These problems in the requirements not only affect the software systems themselves, but they also have implications on actual lives of people. A good example that clearly shows how incorrect requirements engineering can lead to disastrous results affecting actual lives is the well-known problem with the Boeing 737 Max, as extensively seen in

news coverage. In 2018 and 2019, a total of two Boeing 737 Max's crashed due to a malfunction in the Angle of Attack (AoA) system (Johnston & Harris, 2019). This system, having sensors on both sides of the plane, uses only the input from a single sensor as the other sensor functions as a backup. This sensor regulates the horizontal level of the plane when the nose of the plane is too high. This regulation is needed in order to prevent stalling. The data obtained from this single sensor turned out to be wrong, thinking the plane was in danger of stalling, resulting in the plane to automatically push its nose down. The root cause of the problem can be traced back to a weak safety requirement which stated that the AoA system should rely on a single sensor with the assumption that the data obtained from the sensor is correct (Johnston & Harris, 2019). This assumption proved to be false, resulting in the death of 346 people due to two Boeing 737 Max's crashing (Cruz & de Oliveira Dias, 2020). The problem was fixed by altering the requirement, stating that both sensors should be used so that data obtained from both sensors can be compared to each other. This results in the disabling of the AoA system when inconsistent data is sensed, upon which human intervention is needed instead of the automatic actions taken by the AoA system.

This example shows that certain requirements can have detrimental impact on human live and society, and raises ethical concerns when creating these requirements: How reliable should a system be, while still being affordable? In the case of the 737 Max, how many sensors are needed to reliably use the AoA system without unnecessary high costs? Such questions pose ethical dilemmas during the design phase of a software project. Based on Berenbach & Broy (2009), Kopola & Burkhart (2005) and Robinson (2003), this research defines an ethical dilemma as a perceived conflict due to the need of making a choice between two or more competing values, thus (partially) neglecting one of the competing values once a choice is made. However, in the field of requirements engineering, little to no research has been done on incorporating the field of ethics into requirements engineering. In this day and age, where people's lives are more and more in control of software systems and personal data is stored at a vast amount of locations across the world and handled by many different people and systems, it is of the essence that software systems which control these people and store and handle these data, are designed with ethics in mind so that ethical dilemmas are taken into account from the beginning. Therefore, numerous authors stress the need for ethical consideration during the design process of software (Aydemir & Dalpiaz, 2018; Crofts & Leitch, 2005; Jahn et al., 2020). This exploratory research examines how software design with ethics in mind can be realized. More specific, how ethics could be incorporated into requirements engineering, especially the requirements elicitation process. Figure 2 broadly illustrates the focus area of this research.

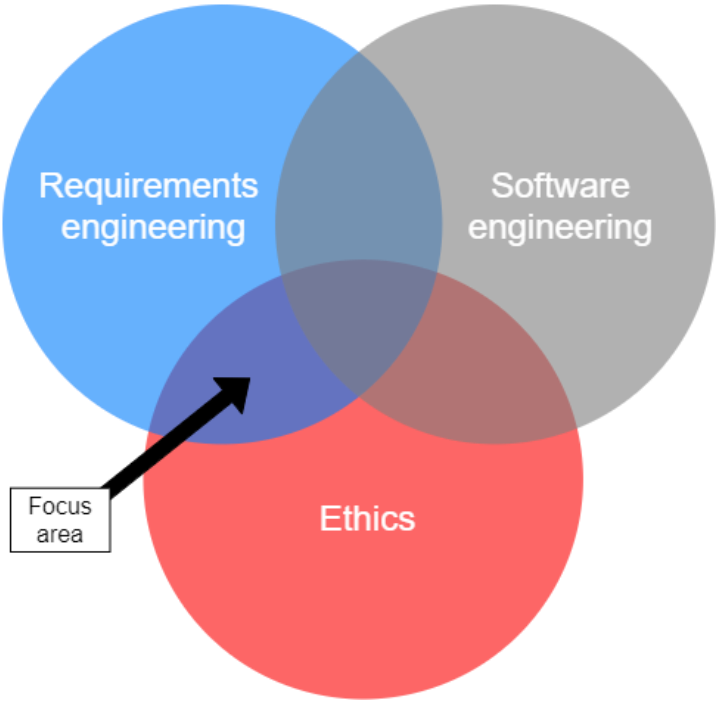

Figure 2. Focus area of this research.

1.2 Research questions

The goal of this research, based on the problem statement above, is to provide an addition to the requirements engineering field by creating a method suitable for incorporating recognition and discussion of possible ethical dilemmas into the requirements engineering process, more precisely, into the requirement elicitation process. By incorporating ethics in such a way as mentioned above, into the process of requirements elicitation, ethical considerations are made from the beginning of the design of a software system. This should lead to a lower number of ethical issues that arise once the system has been created, compared to not taking into account ethical dilemmas from the beginning. Moreover, by storing these ethical considerations, a trace back to these considerations is possible if ethical issues still arise once the system has been created. In short, the following main research goal is defined:

'Creating a method that supports in recognizing, and discussing, ethical dilemmas during the requirements elicitation process.'

In order to answer this main research goal, three research questions (RQ) are formulated which breaks down the research goal into parts that can be researched. These three research questions are discussed next in more detail.

RQ1: How can ethical dilemmas be recognized and discussed during the requirements elicitation process?

The goal of RQ1 is to understand what ethical dilemmas consist of, in order to be able to recognize requirements that could contain an ethical dilemma. Furthermore, its goal is to understand in what way the recognized ethical dilemma can be discussed so that a deliberate choice can be made on how to possibly resolve this ethical dilemma. RQ1 will be answered by a combination of a literature study and expert interviews. A literature study is performed in order to obtain knowledge on how to recognize and discuss ethical dilemmas. Expert interviews are conducted in order to verify, and if needed modify, the technique for identifying these ethical dilemmas.

RQ2: Which requirement elicitation techniques are suitable for the support of recognizing and discussing ethical dilemmas?

The goal of this research question is to gain knowledge about the current state of the art in requirements elicitation techniques and knowledge is gained about how the best requirements elicitation technique, or techniques, can be chosen so that the best possible elicitation can take place. Furthermore, an understanding of these requirement elicitation techniques is required, in order to know which requirements elicitation techniques are suitable for incorporating ethics. RQ2 will be answered by performing an extensive literature study.

RQ3: How can ethical dilemma recognition, and discussion, be combined with elicitation techniques into a method?

The goal of this research question is to understand in what way the recognition and discussion of ethical dilemmas can be combined with elicitation techniques so that ethical considerations take place from the start of software design. This research question will be answered by proposing a 5-step method that makes the recognition and discussion of ethical dilemmas possible during the requirements elicitation process. This method will be validated by performing a case study during a workshop and ending this workshop by conducting a survey.

2 Research method

This research project follows the Design Cycle by Wieringa (2010), a framework that helps structuring a research by providing guidelines for doing design science in information systems and software engineering research. This design cycle consists of three phases and is part a larger five-phase Engineering Cycle (Wieringa, 2010). Due to

the scope of this research, the Design Cycle is chosen instead of the Engineering Cycle. The three phases of the Design Cycle are the *Problem Investigation phase*, *Treatment Investigation phase* and *Treatment Validation phase*. This cycle can be used multiple times as a treatment is deemed insufficient during the treatment validation phase. The Engineering Cycle, with the Design Cycle highlighted with black arrows, is depicted in Figure 3.

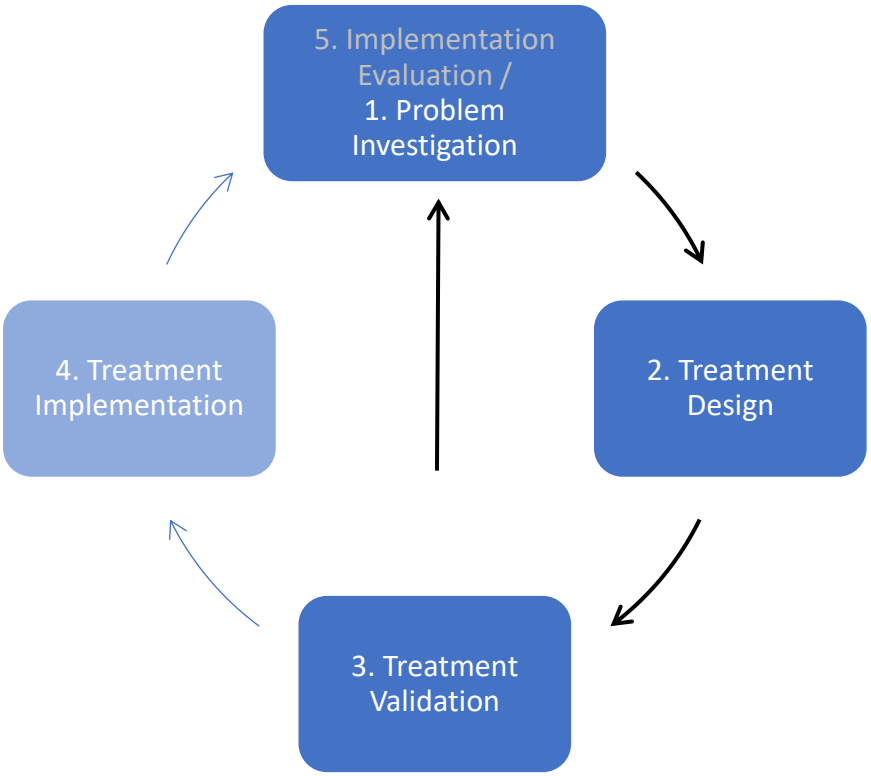

Figure 3. Design Cycle within the Engineering Cycle (Wieringa, 2010).

2.1 Problem investigation

The Problem Investigation phase is used to understand the phenomena that must be improved and why that must happen (Wieringa, 2010). As described in the Problem Statement section, no clear method currently exists that incorporates the recognition and discussion of ethical dilemmas into requirements engineering, more precisely, into the requirements elicitation process. In order to incorporate ethics into this process, it is paramount that possible ethical dilemmas can be recognized. A literature study is conducted in order to find the most common ethical themes within ethical dilemmas found in literature. Based on these ethical themes, a novel technique is created that indicates if a requirement has the potential to raise an ethical dilemma. Once possible ethical dilemmas are found, discussion on these ethical dilemmas is needed to possibly resolves these dilemmas. Therefore, a second literature study is conducted in order to

reveal tools that help in discussing these ethical dilemmas. Also, expert interviews are conducted to validate the technique for recognizing the ethical dilemmas by means of common ethical themes. At the end of these steps, RQ1 can be answered.

In order to understand how the recognition and discussion of ethical dilemmas can be incorporated into the requirements elicitation process, an understanding is needed of which requirement elicitation techniques are suitable for incorporating the process of recognizing and discussing ethical dilemmas into requirements elicitation. This is done in two steps. First, an overview of the most popular requirement elicitation techniques is created by conducting a literature study as requirement elicitation techniques are widely discussed in literature. Second, knowledge is gained on how these elicitation techniques can be used in combination, as it is widely accepted that the use of multiple techniques, instead of a single elicitation technique. When finalized, RQ2 can be answered.

2.2 Treatment investigation

During the Treatment Investigation phase, the acquired information will be used to design a solution for the problem as explained in the problem statement section. A method is proposed, consisting of the following five steps, of which the fifth step is optional:

1. Elicit requirements.
2. Identify the requirements where ethical dilemmas could occur.
3. Discuss the ethical dilemmas.
4. Document the discussions.
5. (optional) Solving the ethical dilemmas.

By adhering to this method, one is able to elicit requirements, recognize possible ethical dilemmas and discuss them, store the discussion in such a way that a trace back is possible and, optionally, make a definitive decision on how the discussed ethical dilemma should be resolved. At the end of this phase, RQ 3 is answered.

2.3 Treatment validation

In the Treatment Validation phase, the results of the Treatment Investigation phase are validated. The proposed method is validation through a combination of a case study during a workshop and a survey and the end of this workshop. A case study is performed

in order to see how the method holds in practice and a survey is conducted so qualitative feedback can be gathered. This feedback is analyzed and gives an indication for the support of this method. The Treatment Validation phase is not constructed as a separate fourth research question but is elaborated on in a dedicated chapter.

3 Literature review

This literature review starts by giving an overview in section 3.1 of the fundamental parts involved in this research, in order to give a broad understanding of the subjects of this research. In the next section, section 3.2, a literature study shows which research has been done on requirements engineering and elicitation. In section 3.2.1, a gap in the literature is exposed by stating that little research is done on which elicitation techniques are suitable for the incorporation of ethics. In section 3.2.2, a gap in the field of recognizing and discussing ethical dilemmas during requirements engineering is exposed.

3.1 Fundamentals

In order to fully comprehend the techniques, methods and tools described in this research, a foundation needs to be laid. This section describes this foundation by explaining the fundamental parts of requirements engineering in section 3.1.1, requirements elicitation in section 3.1.2 and ethics in section 3.1.3.

3.1.1 Fundamentals on requirements engineering

Van Lamweerde (2009) defines requirements engineering a set of activities for exploring, evaluating, documenting, consolidating, revising, and adapting the objectives, capabilities, qualities, constraints, and assumptions that the system-to-be should meet. The processes involved in requirements engineering can be summarized into a model and is called the Requirements Engineering Process. This process is depicted in figure 4. The Requirements Engineering Process consists of four main phases: *Domain understanding and Elicitation*, *Evaluation and Negotiation*, *Specification and Documentation*, and *Quality Assurance* (Van Lamsweerde, 2009). Starting at Domain understanding and Elicitation, each phase outcome acts as an input for the next phase and iterates over all of them until a complete requirements document is delivered. However, these four phases do not need to be applied in a strict sequence, as they may overlap or intertwine and backtracking from one phase to a previous phase may be required.

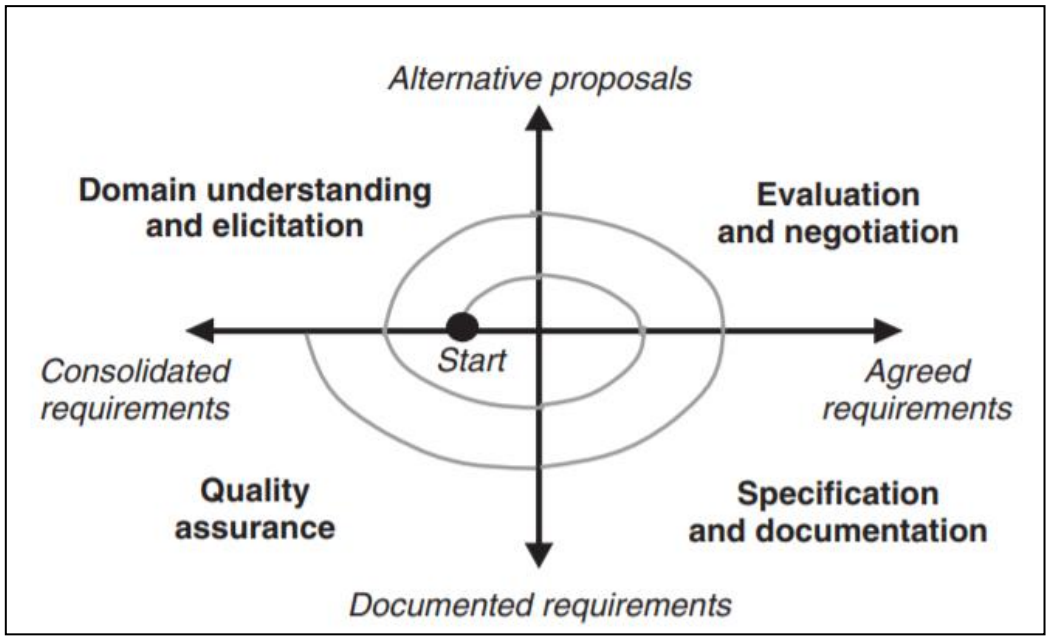

Figure 4. Requirements Engineering Process (Van Lamsweerde, 2009).

3.1.2 Fundamentals on requirements elicitation

During the elicitation process of requirements engineering, the right technique needs to be selected for the project at hand. Although a single technique can be selected, it is widely accepted that a single elicitation technique is not suitable for most projects and that within a project, multiple techniques should be used in order to have a successful elicitation process (Zowghi & Coulin, 2005). A framework has been created by Carrizo, Dieste, & Juristo that helps requirements engineers to select the most adequate elicitation techniques at any time during the process (2014). The method used for selecting the most adequate techniques is shown in figure 5. The input of this method is a new software project where requirements are needed to be elicited. Based on the characteristics of this software project, a *Contextual Situation* is defined by creating 16 attribute-value pairs as seen at the bottom left of the figure. These 16 attributes are pre-defined by the authors and were created by means of an extensive literature study. Each of these 16 attributes are assigned a value, thus creating an attribute-value pair. These values are based on a pre-defined list of possible values (2 or 3 possible values per attribute). Once a Contextual Situation is created, the most adequate elicitation techniques need to be chosen for that particular situation. This is done by mapping the Contextual Situation on an *Adequacy Table*, in order to get a *Contextual Situation – Technique Adequacy Fit*. In the Adequacy Table, each elicitation technique is linked to all the possible attributes-value and for each link, the level of adequacy is marked by having a check mark (the technique can be used if that particular attribute-value pair occurs), a dash (the technique can be used, but only if no better fit occurs) or a cross (the technique should not be used).

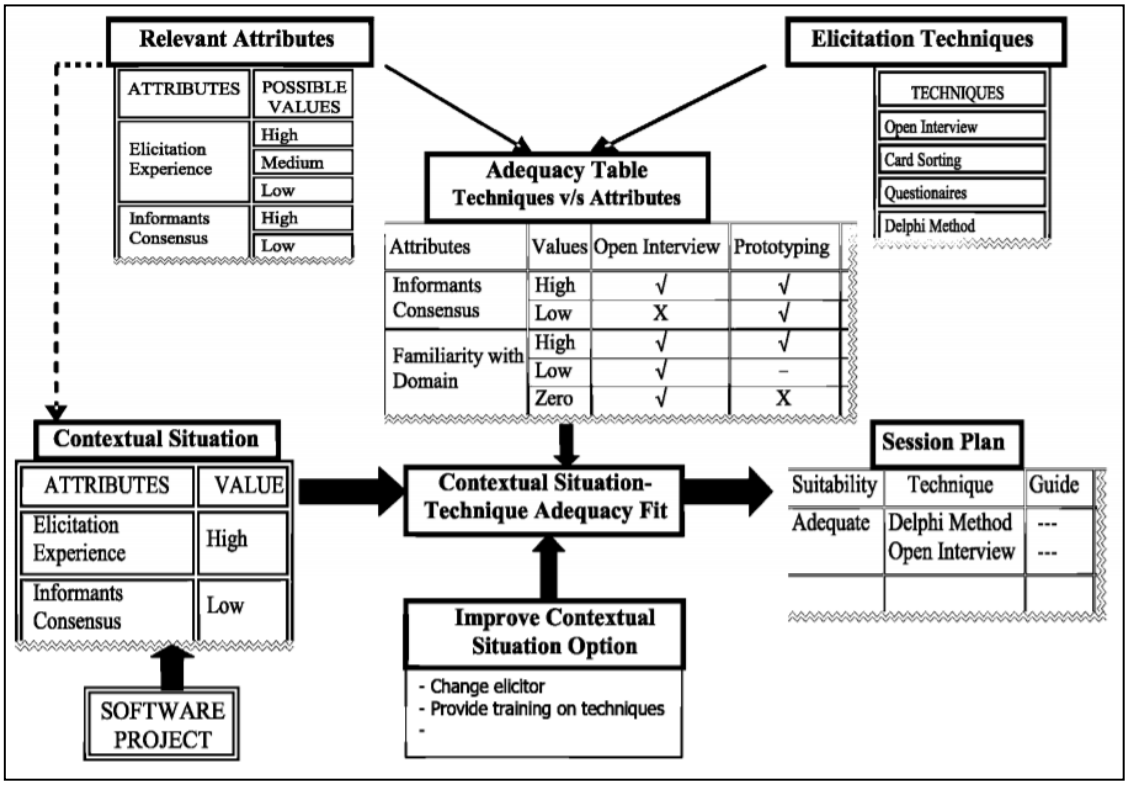

Figure 5. Elicitation technique selection method (Carrizo, Dieste & Juristo, 2014).

By mapping this Adequacy Table to the Contextual Situation, a simple sum can be done by adding up all the check marks, dashes and crosses for each elicitation technique and ordering the list with elicitation techniques by the number of check marks. This results in a *Session Plan* where the adequate elicitation techniques (techniques that have not received a cross) are prioritized. The following techniques incorporated into this framework are based on extensive literature study and are the most commonly researched and used requirement elicitation techniques (Carrizo, Dieste & Juristo, 2014):

Open-ended interview

Interviews are the most traditional form of requirements elicitation where the elicitor asks questions to a person who is knowledgeable of the subject. Due to the fact that the task of asking a question and noting the answer is a very straightforward process, it is the most common technique in requirements elicitation. Open-ended means that limited control over the direction of the discussion is present and no pre-defined list of questions is used. The advantage is that topics may be discovered that were not covered by a pre-defined list of questions. However, a disadvantage could also be that too much focus is put on certain details, neglecting other relevant topics (Zowghi & Coulin, 2005).

Structured interview

As opposed to an open-ended interview, a structured interview follows a pre-defined list of questions to gather specific information therefore making sure that all known topics are covered. However, the effectiveness of this techniques greatly depends on knowing beforehand which questions need to be asked in order to elicit the correct information (Zowghi & Coulin, 2005).

Task observation

During a task observation, the elicitor observes the actual execution of relevant processes by a user, without questioning the user during this process. This technique helps the elicitor to fully understand the current process which results in getting a complete domain understanding. However, the effectiveness depends on the skill of the elicitor to understand the process at hand and not to interrupt the user. Moreover, participants tend to change, (un)knowingly, their behavior when being watched. This can impact the authenticity of the observed actions (Zowghi & Coulin, 2005).

Concept ranking / laddering

With the help of concept ranking, or laddering, requirements are clarified, and domain concepts are categorized and sequenced. This technique starts with the elicitor asking certain questions to the participant. The participant is then required to arrange the given answers in a certain structure. In order to be effective, participants need to be able to express their understanding and arrange them accordingly (Zowghi & Coulin, 2005).

Surveys / questionnaires

Surveys, or questionnaires, are a way for gathering information on requirements from a large number of participants due to ease of sending the survey or questionnaire to each participant quickly. Deep knowledge on the subject is needed beforehand, as the elicitor needs to ask the right questions in order to receive useful answers and to prevent receiving irrelevant information. Furthermore, these techniques lack the ability to delve further into certain topics or expand on new ideas as the content and structure of the survey or questionnaire is defined beforehand (Zowghi & Coulin, 2005).

Protocol analysis

A technique that can be seen as an extension of task observation, protocol analysis involves a participant performing an activity or task. However, unlike task observation, the participant talks aloud and is describing the actions that are taken by him or her. In this way, the elicitor tries to gather specific information of tasks and activities and the rationale for these. However, when talking aloud to a person, the participant may change, (un)knowingly, his or her behavior due to the unnatural way of performing the action or activity. Moreover, seemingly normal and easy steps taken for granted by the participant may not be explained and thus not recorded by the elicitor (Zowghi & Coulin, 2005).

Repertory grid

Using a repertory grid, an overview of domain elements is created. It involves asking stakeholders to give a certain value to an attribute of each domain element. These results are laid out in a matrix, creating an overview of each attribute of each domain element, and its given value. By creating such an overview, similarities and differences can be made between the domain elements, leading to a better domain understanding and more specific requirements. However, the practice of assigning values to attributes of domain elements can be a very abstract process, requiring the ability of the participant to correctly understand these abstractions (Zowghi & Coulin, 2005).

Brainstorming

During brainstorming, participants from multiple stakeholder groups engage in an informal discussion. The goal of this discussion is to quickly generate numerous ideas for the software project, without focusing too much on a single idea. The advantage of a brainstorm session is that participants are free to express everything and thus allowing the discovery of unknown problems and/or solutions to problems. Based on these sessions, preliminary requirements can be made (Zowghi & Coulin, 2005).

Nominal group technique

These techniques involve the gathering of a group, where each member of the group silently defines ideas for the project. Once each member of the group has completed his or her list, each member presents the ideas to the group in order to get a list of all possible ideas that were generated. After the presentation round, members can ask each other questions in order to clarify possible unclear ideas. Finally, all members vote on their favorite ideas from which a ranking is created. This method ensures that each

member of the group has equal participation, unlike during a brainstorm session (Delbecq, Van de Ven & Gustafson, 1975).

Focus group

A focus group is a technique where a group is interviewed in a more structured and formal setting than an interview setting, with room for interactive discussion. Group participants are more precisely chosen, so that each contribute in a specific way. However, not all definitions of focus group contain this last requirement and thus, a focus group can also be seen as a variant of an induvial structured interview (Morgan, 1996).

Delphi method

The Delphi method is a technique that, in a sense, is a controlled debate. In the first round, members of a group are given a list of questions which they can answer anonymously. In the second round, all the results are presented to each member of the group. Members of the group that possess answers that are at the extremes of the range are asked to reassess their opinion and elaborate on their answer by giving a reason. In a third round, all members are asked to reassess his or her opinion and are shown the reasons given for the extreme answers, in order to possibly refute the extreme answers. In the final round, all reassessed opinions are presented, as well as the arguments against the extreme answers. By going through these steps, a consensus should be reached where all members agree on. Based on this group consensus, requirements can be elicited (Gordon, 1994).

Participant observation

Unlike task observation, participant observation is an elicitation technique where the elicitor has an active involvement. The elicitor actively participates in tasks and processes in order to get a full understanding of the domain and thus increase the possibility of eliciting the right requirements. Participant observation is particular useful when task observation was deemed ineffective due to the inexperience of the elicitor and was leading to incorrect interpretations, or when protocol analysis was deemed ineffective due to the users having difficulty with talking aloud whilst performing the task of activity (Zowghi & Coulin, 2005).

Prototyping

With prototyping, the relevant stakeholders are given early prototypes of the software product that has to be developed. This allows the elicitor and stakeholders to support the investigation of possible solutions and allows for detailed information and feedback to be gathered in a quick way. The stakeholders are encouraged to actively participate in the development of the requirements by letting them handle the prototype and give feedback and is therefore a great technique when developing completely new applications. A disadvantage is the high costs that come with the complex development of an early prototype and the fact that some requirements are already needed to make the prototype in the first place. Furthermore, stakeholders can become attached to the prototype and become more resistant to alternative, and possibly better, solutions in the future (Zowghi & Coulin, 2005).

Joint Application Development (JAD) workshop

A JAD workshop involves all available stakeholders participating in a general discussion to investigate the software problems to be solved, and the possible available solutions to those problems. Unlike a brainstorm session, during a JAD workshop the main goals of the system have already been established beforehand. Moreover, a JAD workshop is more structured than a brainstorm session by having defined steps, actions, and roles for participants (Zowghi & Coulin, 2005).

Use cases / scenarios

Use cases, and scenarios, are narrative and specific descriptions of current and future processes, including actions and interactions between the users and the system. They do not typically consider the internal structure of the software system but focus more on the human-computer interaction. With the help of use cases and scenarios, a requirements engineer gets a complete overview of the current and future software system by covering all possible steps that can be taken within the software (Zowghi & Coulin, 2005).

3.1.3 Fundamentals on ethics

Ethics, or moral philosophy, is defined as '*systematizing, defending, and recommending concepts of right and wrong behavior*' and is divided into three main sub fields: meta-ethics, normative ethics, and applied ethics (Fieser, n.d.). Meta-ethics explores the origins of our ethical principles and what they mean. Normative ethics looks at the practical aspects of ethics by looking at how a moral course of action can be determined.

Finally, applied ethics is concerned with what a person needs, or is permitted, to do in a specific situation (Fieser, n.d.).

The field of ethics, can be traced back all the way to Ancient Greek in which Homer's poem Iliad portrays a set of values that needs to be part of a leader in order to be a strong leader of a tribe (MacIntyre, 2003). Ethics is further developed due to Plato's Socratic dialogues *Gorgias* and *The Republic* in which Socrates debates with Athenians and multiple foreigners about the meaning of justice and the meaning of rhetoric (MacIntyre, 2003). These works and authors are now regarded as to be the beginning of ethics as it is now known (Singer, 2011).

With the introduction of the computer, a plethora of new possibilities came to light. All these new possibilities, in turn, create new choices and should be defined into policies. Moor (1985) stresses the need for these kind of policies around the use of the computer and suggest calling this computer ethics. The author proposes to make computer ethics a separate field of study and defines computer ethics as *'the analysis of the nature and social impact of computer technology and the corresponding formulation and justification of policies for the ethical use of such technology*' (Moor, 1985). Johnson (2004) further elaborates on the research of Moor by expanding the field of computer ethics and divide exposed ethical issues into two categories: metatheoretical issues and methodological issues, and traditional and emerging issues such as cybercrime and virtual reality.

Besides integration of ethical consideration, integration of human values is also stressed. Mougouei, Perera, Hussain, Shams & Whittle present a roadmap on overcoming three obstacles when accounting for human values during software engineering and state that '*breaching values, however, may lead to dissatisfaction of the software users, lack of adoption, and devastating socio-economic repercussions such as loss of reputation and money*' (2018). These obstacles are defining human values, current software design decisions being ignorant of values, and determining and quantifying human values. Furthermore, Hussain, Mougouei, & Whittle present a framework to incorporate these human values into Software Design Patterns by specifying the value implications of SDPs, developing or extending SDPs for integrating social values, providing guidance on the value-conscious adoption of design patterns, collecting and analyzing insights from collaborators, maintaining an up-to-date library of the valufied design patterns, and incorporating lessons learned from the real-world adoption (2018). Whittle further stresses the need of incorporating these human values into requirements engineering as evidence from case studies argue that dealing with human values is of interest to all software projects and not just particular projects (2019). Although the consideration of human values shows similarities with ethical consideration, the incorporation of human values is arguably a fully separate field of study and therefor, this research will focus on ethical considerations.

3.2 Related works

This related works chapter exposes the gaps that currently exists in the incorporation of ethical consideration into requirements engineering, more specific, into the requirements elicitation process. Section 3.2.1 will focus on requirements engineering and requirements elicitation aspects and section 3.2.2. focusses on ethics aspects.

3.2.1 Related works on requirements engineering & elicitation

As mentioned during the fundamentals section, the processes involved in requirements engineering can be summarized into a model, which is called the requirements engineering process. The first phase of the requirement engineering process, the elicitation process, is a phase where ethical considerations could be incorporated, however the requirement engineering process currently does not contain any guidelines on how ethical considerations can be incorporated into this process (Van Lamsweerde, 2009).

During this elicitation process of requirements engineering, the right technique needs to be selected for the project at hand. Zowghi & Coulin (2005) state that although a single technique can be selected, it is widely known that a single elicitation technique is not suitable for all projects and that within a project, multiple techniques should be used in order to have a successful elicitation process. A framework has been created by Carrizo, Dieste, & Juristo (2014) that helps requirements engineers to select the most adequate elicitation techniques by mapping the characteristics of a software project to the characteristics of elicitation techniques in order to understand which elicitation techniques are suitable for the project at hand. Moreover, Yousef & Almarabeh (2015) propose a framework that tries to elicitate all possible requirements without popular elicitation techniques. Instead, they use an organization's business process models to create a CRUD-matrix from which the requirements will be elicited. However, in both frameworks, no ethical considerations are incorporated. But, these frameworks can help in understanding which combination of elicitation techniques are suitable for incorporating ethics and thus help in answering RQ2.

3.2.2 Related works on ethics

Tavani (2016) defines ethics as the study of morality, where morality is defined as a system of rules for guiding human conduct and principles for evaluating those rules. He stresses the need for brining ethics into the technology field, such as the engineering field but no concrete methods are given for incorporating ethics into this field in such a way that recognition and discussion of ethical dilemmas are possible. Sinnoth-Amstrong

defines these ethical dilemmas as '*situations where an agent morally ought to adopt each of two alternatives but cannot adopt both*' (Sinnott-Armstrong, 1988). These ethical dilemmas can only be solved, according to Sinnoth-Amstrong, when one of the moral thoughts can override the other moral thought (1988).

Conger, Loch & Helft stress the need for ethical thinking in information technology and identify three issues regarding the interest of using ethics in information technology (1995). The authors state that policies need to be developed that encourage the use of ethics, however, no concrete examples are given.

Aydemir & Dalpiaz (2018) state that ethics should play a role in requirements engineering, more specific, by taking ethics into account during the requirements elicitation process. The authors have created a method for ethics-aware software engineering; however, no specific elaboration is given on which elicitation techniques are suitable for incorporating ethics and no method is given on how possible ethical dilemmas can be recognized. Moreover, the authors state that these ethical considerations need to be articulated in order to be resolved, however, no specific tools are given for this step.

Crofts & Leitch (2005) further urge for the need of ethical consideration during the requirements elicitation process. The authors state that due to the emergence of global software development, requirements engineering is facing a new set of challenges. Due to '*software having to operate in multiple contexts, addressing the needs of different cultures and legal jurisdictions, and having to build safes in different marketplaces'* (Crofts & Leitch, 2005), a new set of challenges occurs that require more ethical thinking. However, besides stating that ethical considerations are needed during the requirements elicitation phase, no concrete techniques, methods, or guidelines are given in order to know how this should be done.

In a paper by Levina (2020), a suggestion is made for identification and implementation of ethical considerations into the design and development of machine learning based information systems. She suggested asking a number of questions during each of the four phases of the Data Science Process by Schutt & O'Neill (2013), where each question should tackle certain ethical aspects. However, creating questions for all possible types of software projects would result in such a long list of questions which would make the technique impossible to use. A second option could be to generalize the questions in order to make them applicable to all types of software systems. However, the issue that arises with this option is that the questions could become too general and therefor do not cover all specific aspects of a certain software system and thus not elicitate all requirements.

Kuhlen (2014) elaborates on certain methods that can be applied in order to identify, discuss, and possibly solve ethical dilemmas. However, the steps that are part of those methods are very general such as '*identify the dilemma'* and '*generate possible*

solutions' (Kuhlen, 2014). No actuals tools or techniques are described that could help with this identification and generation.

Investigating common ethical themes, within ethical dilemmas, in requirements engineering is a practice which is not done broadly. No large systematic literature research has been found that summarizes the most common ethical themes found in requirements engineering. One research that has dived into this subject, is the research done by Aydemir & Dalpiaz (2018). They provide a list with ethical issues in software engineering. However, they state that these are examples and therefor do not cover the whole spectrum of possible common ethical themes. Moreover, no method is given on how these examples are devised. Therefore, based on the lack of research done in this field, this research aims to systematically investigates which ethical themes are common within the field of requirements engineering by performing an extensive literature research and validation and help answering RQ1.

The discussion of ethical dilemmas in requirements engineering is also a practice with little extensive research. However, some research has been done in discussing ethical dilemmas in general with the use of particular tools. In this research, the aim is to apply these tools for the discussion of ethical dilemmas to the requirements engineering field. A tool originated by Helwig (1948) and further developed by Von Thun (2013), called the Square of Values, can be used to position a discussion around a value, for example, a theme within an ethical dilemma. The intent of the Square of Values is to find out the opposite of the value and their respective extreme values, in order to help you better reason about the current issue at hand, because you can better estimate how far away from the extreme the issue is. Rachmann (2019) brought this tool into information technology by using this tool within the business informatics field. Therefore, it should be possible to use the Square of Values for discussing ethical dilemmas within requirements elicitation where one ethical theme is present. This tool, therefore, helps in answering RQ1.

A second tool used for the discussion of ethical dilemmas is proposed by Jahn et al. (2020). They suggest combining three possible design solutions for ethical conflicts. First, an initial solution is suggested without prior knowledge around the subject of ethics. Second, an ethics workshop is given from which a second possible solution is devised. The third possible solution is the so-called regulative idea. The authors state that a regulative idea '*gives agents an idealized projection which serves as a horizon to which they can orient their actions*' and thus '*would best address the respective conflict if we had unlimited resources during the project'* (Jahn et al., 2020). By having these three possible solutions, a discussion for the right solution is easier to have as the three possible solutions can act as a guideline. This tool can be used to discuss ethical dilemmas where multiple ethical themes occur as each theme can be a separate row in the table which holds the possible solutions, and thus help in answering RQ1.

4 Interview results on ethical themes

This chapter describes the most important and relevant findings from the expert interviews. The intent of these interviews is to validate seven common ethical themes that were discovered during the literature study, which are shown in table 1. Using the search query 'common themes in ethical dilemmas' in Google Scholar, scientific papers and/or books are studied in order to find common ethical themes. Scanning the papers of the first two results pages, as more results did not lead to more themes, resulted in 12 relevant papers which, in turn, had a total of seven common themes that showed up in more than one paper. An interview template was used during the interviews so to have a more controlled environment where the expert knowledge is gathered.

The interviewees were questioned regarding each of the seven discovered common ethical themes: *Individual vs. Group*, *Privacy*, *Difficulty*, *Lack of Resources*, *Lives*, *Security*, and *Fairness*. This was done in order to understand if these ethical themes are actual present in real life situations or not. Moreover, the interviewees were asked if they could think of more common ethical themes besides the aforementioned seven. With these seven ethical themes, identification of ethical dilemmas is possible, which will be elaborated on in chapter five, more specific, section 5.3. The template of the expert interviews can be found in Appendix 1. Section 4.1 gives a demographic overview of the interviewees, while section 4.2 elaborates on the qualitative results.

Table 1. Overview of common ethical themes.

Ethical theme	Explanation	Example	Reference
Individual vs. group	Ethical dilemmas that occur due to an individual placing his or her own values above the ones of a group, or vice versa.	Choosing whether a requirement must be implemented that positively affects a certain group but negatively affects one individual.	Cranston et al., 2006 Eyal et al., 2011 Norberg & Johansson, 2007 Sinnott-Armstrong, 1988 Vyakarnam et al., 1997
Privacy	Ethical dilemmas that occur due to privacy issues concerning the users of the system that needs to be developed.	Choosing if a requirement, that leads to a more effective software system but impacts the privacy of the users, must be realized.	Barnitt, 1998 Ferrell et al., 2001 House et al., 2015 Kelly & Nisker, 2009 Rainer, 2018

Difficulty	Ethical dilemmas that occur due to requirements being too difficult and therefore not being able to (fully) realize.	Choosing if a requirement, that needs expert knowledge not currently available to a company, must be realized as the requirement will positively affects the effectiveness of the software system.	Barnitt, 1998 Ferrell et al., 2001
Lack of resources	Ethical dilemmas that occur due to low or no resources such as money, hardware, or software.	Having multiple requirements that all have an equal advantage to the software system but cannot all be chosen due to limited budget.	Barnitt, 1998 Cranston et al., 2006 Ferrell et al., 2001 Kelly & Nisker, 2009 Rainer, 2018 Thompson, 1988
Lives	Ethical dilemmas that occur due to having certain requirements that can affect lives of human beings or animals.	Choosing how reliable a heart monitor should be, as a percentage of time, as 100% of the time is not realistic for software.	Barnitt, 1998 Ferrell et al., 2001 House et al., 2015 Kelly & Nisker, 2009 Rainer, 2018
Security	Ethical dilemmas that occur due to requirements that affect security of people, animals, hardware, or software.	Choosing how much resources must be allocated to the security of a software system as doubling a budget may not lead to doubling the security.	Dakin & Pearlmutter, 2009 Norberg & Johansson, 2007
Fairness	Ethical dilemmas that occur due to requirements that have impact one fairness related issues. such as diversity and transparency.	Accepting a requirement that may have a bias towards only male users and not female users.	Aydemir, & Dalpiaz, 2018 Jahn et al., 2020

4.1 Demographic results

Two experts on requirements engineering at the Dutch Police were interviewed according to the aforementioned appendix. These interviews were held with these people in particular as these have extensive experience in the field of requirements engineering and know how it is currently done at their company. By interviewing them, we can understand if the current seven ethical themes are relevant. As the Dutch Police is the biggest employer of the Netherlands, their software engineering division is arguably one of the largest also. With this in mind, knowing if the seven ethical themes are present at the Dutch Police, it can be argued that these ethical themes could also be common at other software engineering divisions at other companies. While all interviewees were sufficient in English, the choice has been made to take both interviews in Dutch in order for the interviewees to better articulate themselves.

Table 2. Demographic overview of interviewees.

Nationality	Position	Experience (years)
Dutch	Strategic Advisor Architecture	9+
Dutch	Lead Data Architect	15+

Each interview was completed in one session, so two sessions in total for both the expert interviews. Interviewee 1 is a Strategic Advisor Architecture with more than 9 years of experience in his field and interviewee 2 is a Lead Data Architect with over 15 years of experience. Table 2 gives an overview of these interviewees.

4.2 Qualitative results

When discussing the first common ethical theme found in literature, *Individual vs. Group*, interviewee 1 states that he recognizes this issue during software development, where they choose to prevail usability of the user instead of the developer and that it can be difficult to know if the piece of software that is being developed, will fit to everyone. This leads to many ethical discussions. He mentioned that '*First, a user will quickly choose a piece of software that is easy to use for that specific user but who is this person? Does he represent all users? Second, how do I make sure that the software that I deliver is capable of being applied in general? Which could take more time*.' The interviewee states that in that case, he perhaps chooses the quick way, which may result in software not being able to represent all users and mentioned that the choice is therefore sub-optimal. Interviewee 2 observes that there is always a balancing of interests and that decision can be in the hands of someone who puts his or her values above the others.

Regarding the second common ethical theme, *Privacy*, interviewee 1 sees a lot of discussion around this topic due to it being very relevant in this day and age. Especially at the police where they need to take privacy into account regarding the civilians but also their employees. He believes that during development, they focus more on the privacy of the civilians, than the employees. An example given by the interviewee, with regards to privacy discussions, is DNA. He illustrates that during forensic analysis, the DNA of the victim or the suspect could accidently be contaminated with DNA of the forensic expert. In order to check this possible contamination, a database with the DNA of all employees for cross reference would mitigate this problem. However, this cannot be done due to privacy concerns of the employees. This has led to much discussion around privacy and the ethical aspects involved. He further exemplifies this by stating that '*We have logging servers that keep track of all actions, where certain controls have been built in so that not all actions are visible to everyone to protect the privacy of the involved individuals*' and that designing software systems with privacy of the user in mind is a big issue which often results in discussions around this topic. Interviewee 2 agrees that privacy is an important theme and much discussed. He notes that there are strict laws and guidelines on how to act when privacy comes to play. These guidelines are based on laws. However, he states that '*There is a strict framework within the law stating which powers we have regarding privacy, but the issue is that the law is somewhat outdates and does not always clearly states everything.*' According to interviewee 2, this can lead to ethical discussions.

During the discussion of the common ethical theme *Difficulty*, interviewee 1 states that he questions if the discussions regarding this theme are in fact ethical discussions or rather discussions on capacity, but states that ethical discussions around this topic sometimes are present. Het mentioned that '*We go through a lot of effort in making information accessible and searchable for intelligence related work, but data visualization would make this even more effective. But we often do not have the knowledge for that, so we choose not to do this because this knowledge is not easily accessible*.' He further exemplifies this by the fact that they need to anonymize a lot of data and that the algorithms they design need good quality data, which cannot always be the case when all information is anonymized. Good knowledge and tools are something that is difficult for them to gather. Choosing whether or not to look for this knowledge, which helps improving their software, leads to many discussions. Interviewee 2 also sees difficulty related issues during requirements engineering, especially when high level management requests solutions but developers do not know how to do it. He says '*Management wants a screen like this and a system like that. However, when these global statements need to be worked out, numerous questions are raised regarding how to do that'*. This is probably due to requirements being too vague, leading to developers believing that the requirement is too difficult.

Taking about the fourth theme, *Lack of Resources*, interviewee 1 found this theme a bit more difficult by stating that dilemmas often occur but doubts if these are always ethical. However, he states that '*It is an interesting point, as we always have limited capacity, both on the street and with software development, so choices are always made. This results in a choice for functionality first and non-functionals second*.' He exemplifies this by the fact that sometimes the choice is made for using the available resources for a good looking and easy to work with interface instead of focusing on privacy- or security-by-design principles. Discussions around this choice could results in ethical dilemmas. This view is also shared by interviewee 2 but also doubts if these discussions are ethical. However, he states that regarding having discussions around this topic: '*We have these discussions chronically, sometimes it is about order of operations, sometimes it is about doing one thing and not the other thing, and sometimes we talk about doing only 50% of it*'. These types of considerations can be ethical dilemmas.

When discussing the ethical theme *Lives*, interviewee 1 responded by stating that software design related to actual lives does not often occur within the police. However, he does state that it can happen, although sometimes indirectly such as when a notification appears that someone on the street is carrying a gun. In that case, the effectiveness of the notification system can indirectly contribute to the saving of lives. Therefore, the interviewee states that '*The IT environment is vital and because of that, they use back-ups and emergency generator. We see that the role of IT has changed in recent years and adapt accordingly.*' He further mentioned that therefor discussion around the effect of these system not working, and thus impacting actual lives, is very relevant but also notes that these discussions would occur more frequently in settings such as a hospital. In accordance with interviewee 1, interviewee 2 does not see many ethical discussions during requirements engineering that directly impact lives. However, he realizes that certain aspects of police investigations could impact lives. He exemplifies this by stating that '*Automatic processing of imagery found on the dark web and other parts of the internet could be matched with our own data in order to be able to recognize issues that are worth prosecuting. This could eventually relate to actual lives'*. He, however, states that this could be a large invasion of privacy if lawful imagery is processed. Deciding how to cope with these kinds of issues leads to many ethical discussions.

Regarding the sixth ethical theme, *Security*, Interviewee 1 agrees fully on the statement that this theme is present during software design. He responds on the question 'Does this security aspect occurs at your company?' by stating: '*Yes, always. It is even an obligation. The security of data must always be an intrinsic part the design. It is a strict legal obligation and dilemmas are often found there.*' A current example he gives is the ethical dilemma that occurs due to the fact that police officers are increasingly working from mobile devices. This leads to discussions about a trade-off between security and workability when police officers need to use a mobile device, because increased device

security often leads to a decrease in workability of that device. Interviewee 2 states that, just like with privacy, there are many laws and regulations that state how to handle security, but these laws and regulations are not always that clear. This, again, leads to different interpretations of these laws and thus dilemmas.

During the discussion of the last common ethical theme found in literature, *Fairness*, interviewee 1 responded by stating that '*Yes of course, we are often accused of it, but there is a legal prohibition on discrimination and profiling. However, police officers must do some kind of profiling in order to know when or if to act*.' As an example, he mentioned an automated system that detects where home burglary takes most often place, based on data gathered by the police. This automated system could indicate areas where people live with a certain ethnicity and therefor patrol more in that area which in turn results in more sightings of home burglary and thus more patrolling, creating a snowballing effect. According to interviewee 1, creating these kinds of software systems leads to much discussion around this ethical theme. Interviewee 2 also mentioned profiling as a fairness theme on which much discussion takes places. He states that '*There is enough talk about ethnic profiling, but I do not believe this issue is not tackled on the level of requirements. However, we are very careful in what we register about someone who committed a crime*.' Incorporating awareness around this ethical theme during requirements engineering might improve their level of adherence to profiling.

Based on these interviews and the literature study, it can be concluded that all seven common ethical themes are in fact common in requirements engineering and should cover most, if not all, ethical dilemmas. Both interviewees agree that these seven ethical themes are present during their development cycles but are not always sure if certain dilemmas are actually ethical. However, this is more a discussion of semantics as the dilemmas mentioned by the interviewees are ethical dilemmas according to the definition of this research. Moreover, both interviewees could not think of more ethical themes that do not cover the aforementioned seven common ethical themes.

5 Method

This chapter describes the proposed solution of incorporating ethics into requirements engineering by introducing a method that identifies possible ethical dilemmas during the requirements elicitation process, subsequently discusses these ethical dilemmas with the assistance of a tool, stores the discussion, and finally, gives the possibility to make a decision on how the ethical dilemma should be solved. In summary, this method consists of five steps, which are shown below in table 3. Starting with a description of the overall method in section 5.1, each step within the 5-step method is described in its own dedicates section, starting with the description of step 1 in section 5.2.

Table 3. The five steps of the proposed method.

Step	Optional	Description
1	No	Elicit requirements.
2	No	Identify the requirements where ethical dilemmas could occur.
3	No	Discuss the ethical dilemmas.
4	No	Documenting the discussions.
5	Yes	Solving the ethical dilemmas.

The proposed method as a whole and the five specific steps within the method are visualized with the Process-Deliverable Diagram (PDD) technique (Van de Weerd & Brinkkemper, 2009). With the use of PDDs, a clear picture can be presented of the processes of the method and corresponding outputs of these processes. A PDD specifies the process part of the proposed method as a UML activity diagram and specifies the output part of the proposed method as a UML class diagram. Furthermore, the Intergranova model-driven technology and the OO-Method is used for relationship roles and cardinalities of the class diagram (Pastor & Molina, 2007). The corresponding notation of the PDD technique is shown below in figure 6.

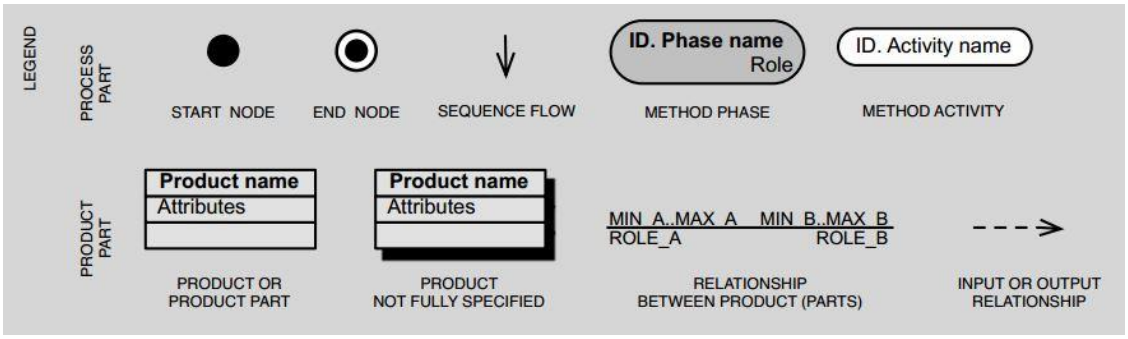

Figure 6. Notation of the PDD technique.

5.1 Overall method

The method proposed in this paper consists of five steps that need to be followed in order, of which the last step is optional. The five steps are: 1. *Elicitate requirements*, 2. *Identify the requirements where ethical dilemmas could occur*, 3. *Discuss the ethical dilemmas*, 4. *Storing the ethical dilemmas* and 5. *Solving the ethical dilemmas*. This last step is optional as the main goal of this paper is to provide a method that makes

recognizing and discussing ethical dilemmas possible. The actual solution to an ethical dilemma is of course a desired effect but not a goal in itself as ethical dilemmas cannot always be solved. The PDD in figure 7 shows these five steps, with their corresponding inputs and outputs.

The first step of the method, at the beginning of the development of a new software project, is eliciting requirements. The requirements are needed for this method in order to identify the requirements where ethical dilemmas could occur. Based on the specific context of a company, one or more requirement elicitation techniques are chosen and executed. This first step leads to a requirements document that holds all the requirements of that software project. Note that this proposed method can be followed even if not all requirements are elicited, as at least one requirement is needed in order to follow the method.

The second step of the method identifies which of the elicited requirements could lead to possible ethical dilemmas. This is done by identifying certain ethical themes that are common in ethical dilemmas. These common ethical themes are: *Individual vs. Group*, *Privacy*, *Difficulty*, *Lack of Resources*, *Lives*, *Security*, and *Fairness.* When a requirement holds one or more of these ethical themes, this requirement is identified as a requirement where an ethical dilemma could occur and can be discussed in during the next step.

The third step discusses the ethical dilemmas that have been identified in the previous step. With the help of specific ethical tools for thinking, the ethical dilemmas are framed in such a way that discussion on the dilemmas is easily possible. The use of these tools thus leads to discussions on these ethical dilemmas which paves the way for a possible solution for the ethical dilemmas.

The fourth step of the method consists of documenting the discussions that were held in the previous step. By documenting and storing these discussions, together with the corresponding requirement and used ethical tool for thinking, it will be easier to trace back to a discussion when needed in the future and can act as an archival tool.

The final, and only optional, step of the method is solving the ethical dilemmas. Stakeholders and the requirements engineer retrieve the stored discussion, together with the relevant requirement and the ethical tool for thinking that was used, and try to make a decision on how the ethical dilemmas could be solved.

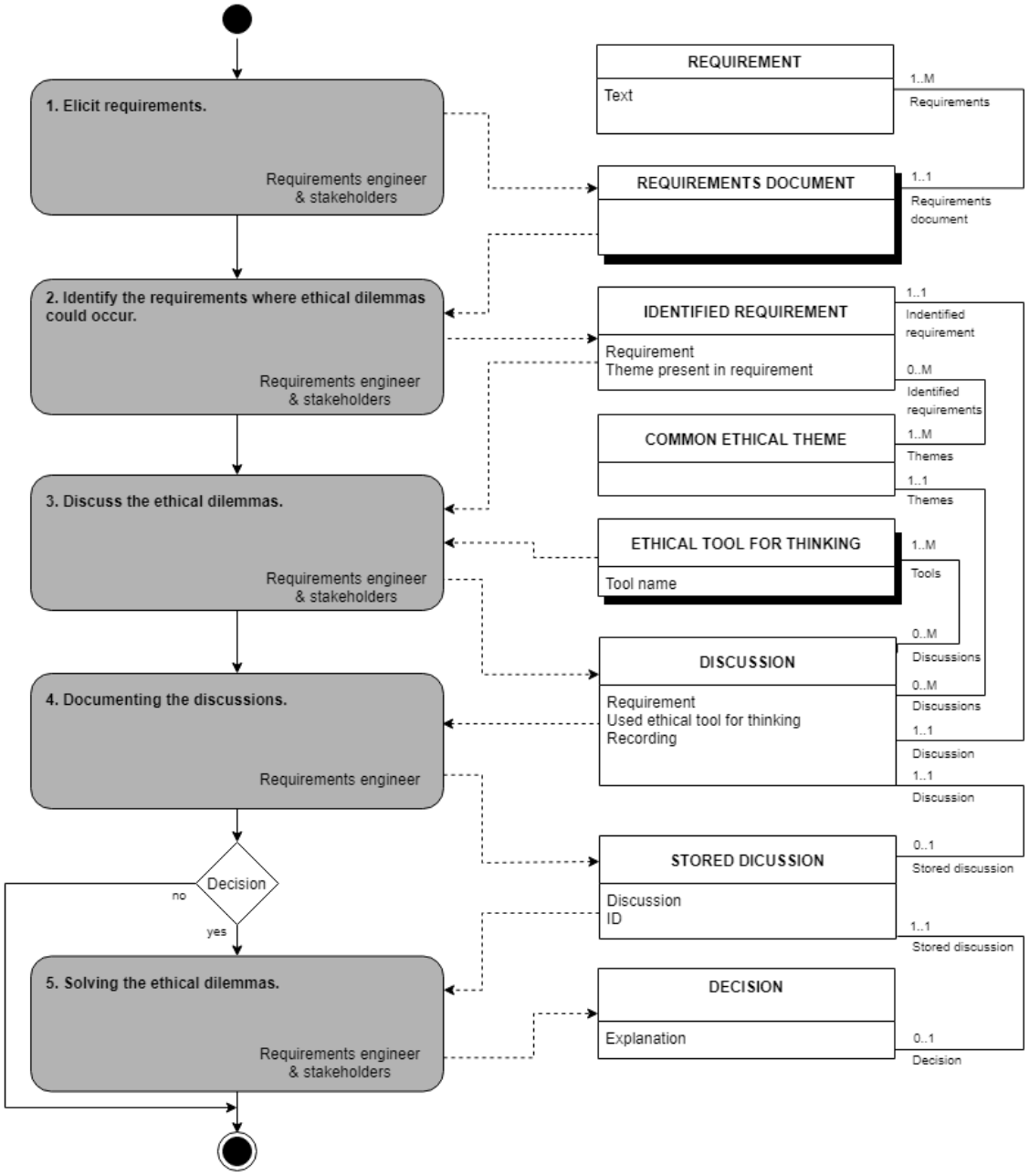

Figure 7. Overall structure of the proposed method.

In the next five sections, each of the five steps from the overall method is described in finer detail. This is done by singling out each individual step in its own section and zooming in on the processes and outputs within that individual step, by means of PDDs and explaining each individual activity within that step.

5.2 Elicit the requirements

The first step of the proposed method is used to start the requirements elicitation process in order to obtain the actual requirements. Figure 8 shows this first step called *Elicit requirements* by means of a PDD. The left side of the PDD in figure 8 shows the four main activities within this step and the right side shows the input and output of these activities.

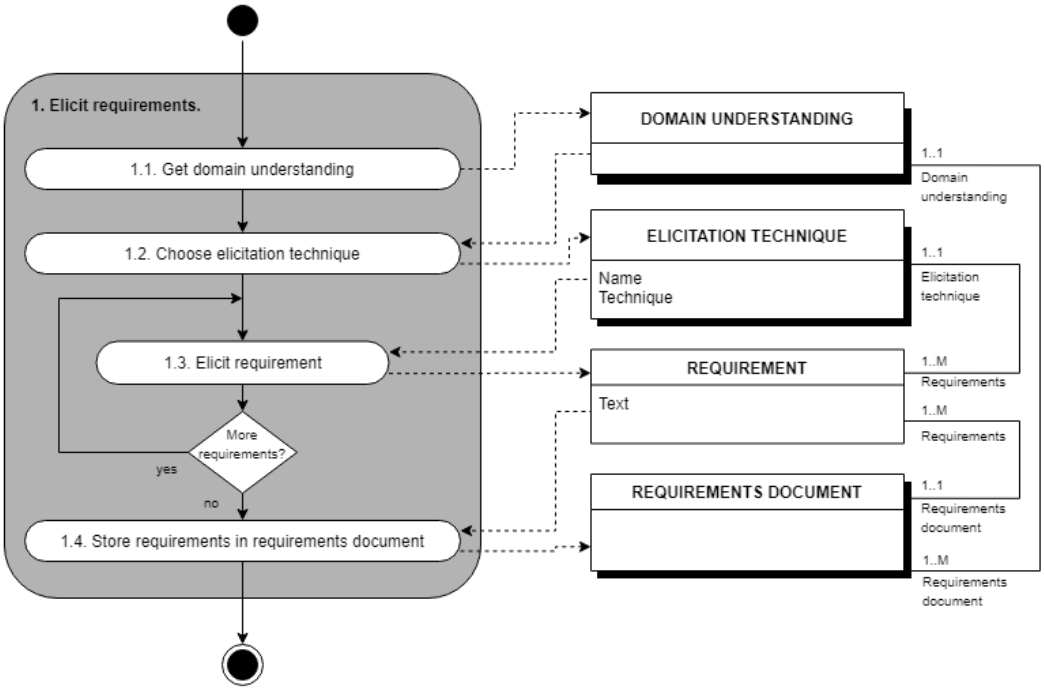

Figure 8. Detailed PDD of the elicitation step.

The first activity is the gathering of domain understanding of the company at hand, by the requirements engineer. This can be done by interviewing the stakeholder of the company in which a new software product is to be developed. By performing these interviews, the requirements engineer collects domain understanding and thus gathers knowledge on all aspects of the company related to the software project. With the help of this domain understanding, the requirements engineer can move to the second activity. This second activity is about choosing the right elicitation techniques in order to obtain the best requirements. Based on the specific characteristics of the company, obtained from the domain knowledge, the requirements engineer chooses the elicitation techniques best suitable as mentioned in section 3.1.2.

Once these elicitation techniques are chosen, the requirements can be elicited, which is the third activity in this step. And once enough requirements are elicited according to the requirements engineer and stakeholders, the final activity can be started: storing the requirements in a requirements document. Once this final activity has been completed, the next step can be started: identifying possible ethical dilemmas.

5.3 Identify possible ethical dilemmas

If the last activity from the previous step is finished, the second step from the overall method can be started. This step, called *Identify the requirements where ethical dilemmas could occur,* is depicted in figure 9 as a PDD with on the left side the four main activities and on the right side the input and output of these activities. The output of the previous step, a requirements document, serves as the input of this step.

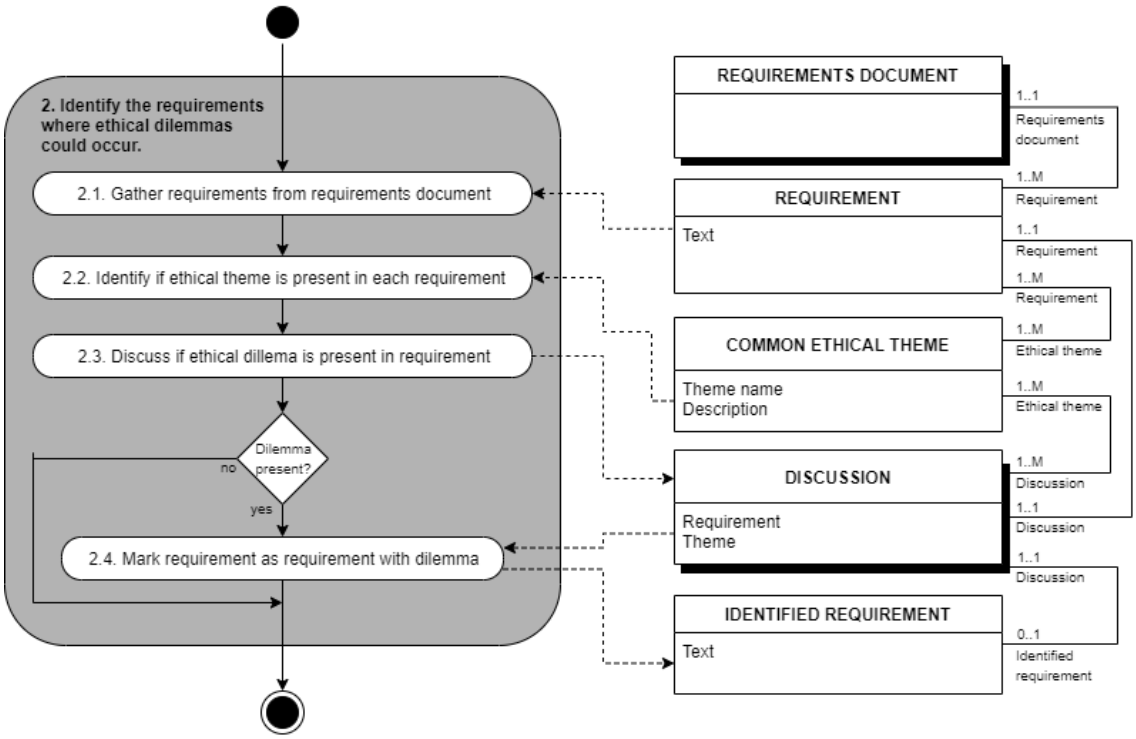

Figure 9. Detailed PDD of the identification step.

The second step starts with the first activity of retrieving the requirements document that was produced in step one. Once the requirements document is available, the identification of requirements that have possible ethical dilemmas can start. This identification is the second activity and is done by searching for common ethical themes, that are present in ethical dilemmas, in the requirements from the requirements

document. An overview of the results of the literature study can be found in Table 4. With the help of this table, a requirements engineer can scan the relevant requirements in order to find requirements that possess an ethical theme.

When a requirement that possesses a common ethical theme is identified, a discussion can be started in order to decide if an ethical dilemma is actually present. This discussion is the third activity of step 2. If no ethical dilemma is present in a requirement, the requirement poses no threat and therefore has no use within the method and can be discarded. If it is decided that an ethical dilemma is present in the requirement, the fourth activity can be executed, which consists of marking the requirement as a requirement with an ethical dilemma. If this fourth activity has been completed, one can start with the next step from the overall method. This third step focuses on the discussion of ethical dilemmas.

Table 4. Overview of ethical themes.

Ethical theme	Explanation
Individual vs. group	Ethical dilemmas that occur due to an individual placing his or her own values above the ones of a group, or vice versa.
Privacy	Ethical dilemmas that occur due to privacy issues concerning the users of the system that needs to be developed.
Difficulty	Ethical dilemmas that occur due to requirements being too difficult and therefore not being able to (fully) realize.
Lack of resources	Ethical dilemmas that occur due to low or no resources such as money, hardware, or software.
Lives	Ethical dilemmas that occur due to having certain requirements that can affect lives of human beings or animals.
Security	Ethical dilemmas that occur due to requirements that affect security of people, animals, hardware, or software.
Fairness	Ethical dilemmas that occur due to requirements that have impact one fairness related issues. such as diversity and transparency.

5.4 Discussion of ethical dilemmas

Having finished the identification step, the third step can be started. Figure 10 shows the third step, depicted with a PDD. This step, called *Discuss the ethical dilemmas*, takes the output from the previous step as input. The left side of the PDD shows the three activities and the right side of the PDD shows the corresponding inputs and outputs of these three activities.

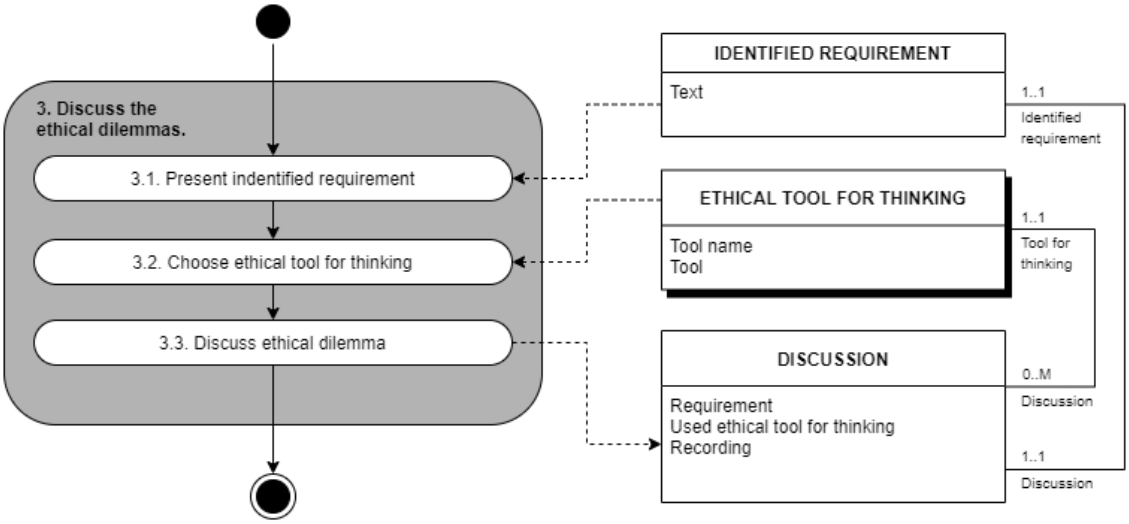

Figure 10. Detailed PDD of the discussion step.

This third step begins with the activity of presenting the identified requirements to all stakeholders involved in discussing the requirements. These identified requirements are the requirements that were identified in the previous step as requirements holding an ethical dilemma. Based on the number of ethical themes present in a requirement, a specific tool is chosen that helps the stakeholders discuss the ethical dilemma. The choosing of this specific tool is the second activity within this step. A literature research has resulted in two types of tools that can help in discussing an ethical dilemma, based on the number of common ethical themes present within a requirement. However, other tools can be easily added as the overall structure of the method remains the same. This results in a method where other tools can be simply plugged in.

The first tool that can be used in aiding the discussion of ethical dilemmas is the Square of Values (Von Thun, 2013). The goal of this tool is to position a certain value, such as a common ethical theme, in relation to its positive tension and its exaggerations. When such a relation is made explicit, it paves the way to a discussion so that a possible solution could be centered somewhere between those two opposites. Rachmann (2019) incorporated this tool into the business informatics field and therefor shows a possibility that this tool could be used within the requirements engineering field. The Square of

Values can be used in the discussion of an ethical dilemma when only one ethical theme is present in the requirement as the Square of Values cannot incorporate two or more values in one figure. By locating these conflicts inside the Square of Values and estimate how far away from extreme positions their outcomes are, better reasoning about the conflict is possible.

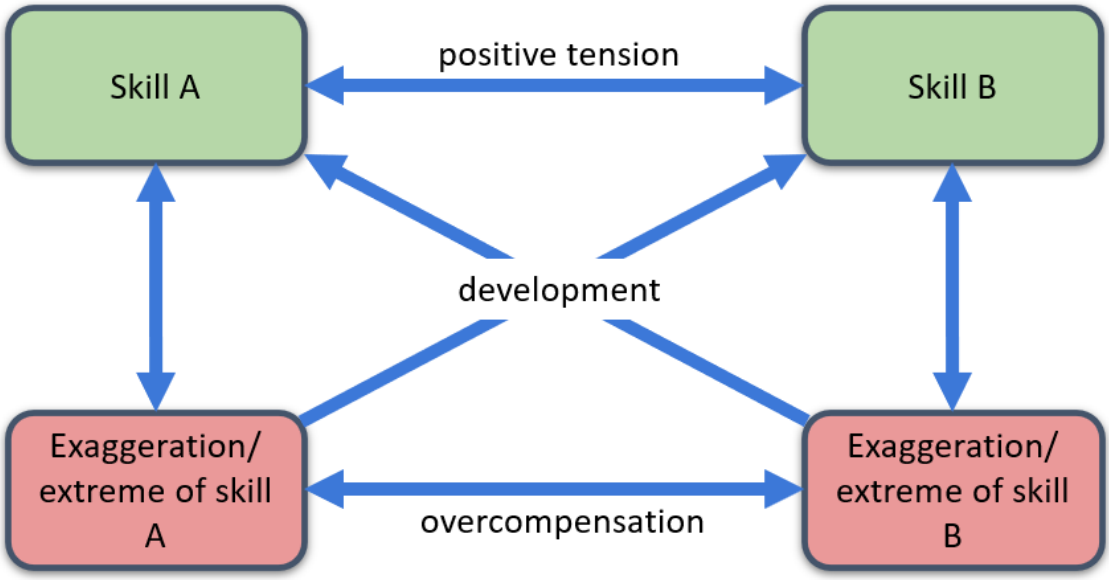

Figure 11. Template of the Square of Values (Rachmann, 2019).

A template of the Square of Values is shown in figure 11. It shows that in the top left corner, Skill A is placed. In the proposed method, this would be the common ethical theme found in the requirement. In the top right corner, Skill B is placed, which in our method would be the positive tension of the common ethical theme placed in the top left. Below each of the two top corner positions, an exaggeration or extreme is placed in the opposite bottom corner of each skill. The diagonals in the square indicate desirable development directions away from extreme positions.

An example of the Square of Values, using the common ethical theme privacy, is shown below in figure 12. In the top left, the results of a certain requirement are placed, namely: '*Requirement leads to better security*'. As shown in the template above, in the top right corner an opposite or positive tension has to be placed. In this example the opposite is: '*Requirement leads to better privacy*'. Below each of these, the exaggeration or extreme is placed. For '*Requirement leads to better security*', the exaggeration or extreme is '*Total control over person*'. And for its positive tension '*Requirement leads to better privacy*', the exaggeration or extreme is '*Total isolation of person*'.

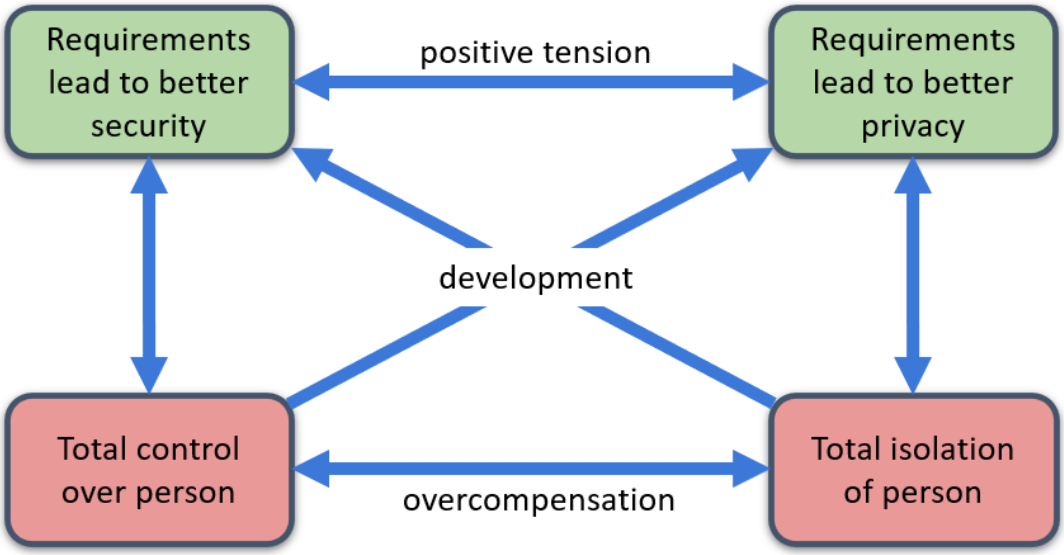

Figure 12. Example of the Square of Values.

A second option for aiding the discussion of ethical dilemmas is a method used by Jahn et al. in a paper from 2020. They suggest combining three possible '*design solutions*' for an ethical conflict into a single table. If more than one ethical conflict is present, the possible solutions can simply be added to the table as an extra row. Therefore, this option is ideal for requirements where more than one ethical theme is present. The idea behind this method is to first have an initial solution suggested without prior knowledge around the subject of ethics. Second, an ethics workshop is given by an expert, from which a second possible solution is given. The third possible solution is the so-called regulative idea, which is an idealized solution. By having three possible solutions, a discussion around the ethical dilemma is made easier as the three possible solutions can act as a guideline.

Table 5. Three possible design solutions (Jahn et al., 2020).

Norm	Initial Solution	Solution after the Ethics Workshops	Regulative Idea
Privacy	Saving data pseudonymized on VR-Computer.	Higher degree of data security as default with encryption; autonomy to decide otherwise.	Saving data locally on a patient's device; absolute authority; encryption; complete anonymization.
Non-Exclusion of Participants	Adaptation to users' height.	Adaptation to users' height.	Adaptation to users' height and addressing additional senses (smell,

			hearing etc.) for visually/physically impaired users.
Danger of Discrimination	Not included in design.	Not included in design, but with explanation.	Empathy training to reduce bias against smokers as additional training in project.

Table 5 shows three examples created by Jahn et al. (2020) around three '*Norms'*, which are the ethical themes in this research. The three norms in the example are '*Privacy*', '*Non-Exclusion of Participants'* and '*Danger of Discrimination'*. For each of these norms, the three possible design solutions are shown in each respective row. Table 6 shows how the two aforementioned tools compare to each other.

Table 6. Comparison of the two example tools for thinking

	Square of Values	**Three design solutions**
Number of ethical themes within a requirement	1	2+
Time to completion	Short	Long
External supervision needed	No	Yes (due to the workshop)

Once the ethical dilemmas have been discussed, the third step is finished, and the next step can be started. This next step, the fourth step, is about storing the discussions created during step three.

5.5 Documenting the discussion

Once the third step has been completed and the ethical dilemmas have been discussed, the fourth and final mandatory step of the method can be started. This fourth step is the final mandatory step as the fifth step cannot always be completed and is therefore optional. The fourth step is called *Storing the discussion* and is depicted as an PDD in figure 13, where the two main activities are shown on the left side and their corresponding inputs and outputs on the right side.

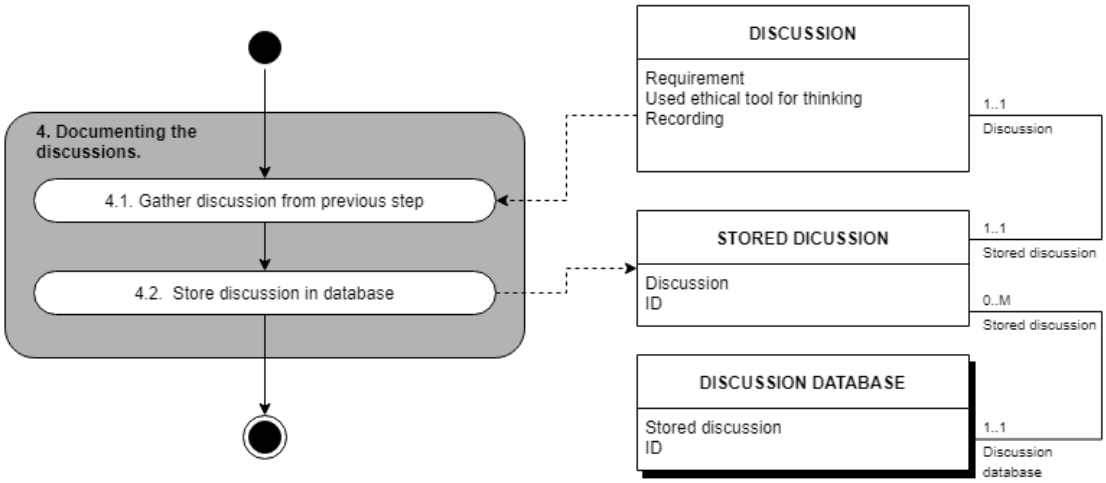

Figure 13. Detailed PDD of the documenting step.

The first activity in this step is retrieving the discussion around the ethical dilemma from the previous step, step three. This discussion has the requirement on which the discussion is focused on, the ethical tool for thinking that has been used for the discussion, and the recording of the discussion. The recording of the discussion can be necessary when the solving of the discussion, which is the next step in the method, takes places at another time and/or place. In that case, the recording can be used to remind all participants on the contents of the discussion. If the possible solving of the ethical dilemma takes place immediately after step three and four, the recording is not needed for reminding the participants. In that case, the recording is only used for archival purposes.

The second activity of this step is storing the discussion in a database. In such a database, which can be a simple SQL database, all discussions are stored so retrieval is made quick and easy for the next step in the method. Furthermore, this database can be used for archival purposes so they can be retrieved in the future when necessary. Once the discussion has been stored in the database, the last activity from step four has been completed, which allows for the start of the next, and final, step of the method.

5.6 Solving the ethical dilemmas

The final step of the proposed method can be started once the discussion from the previous step has been finished and stored. This fifth step is called *Solving the ethical dilemmas* and starts with the output from the previous step, as input. A detailed PDD on this fifth step is shown in figure 14, containing the three main activities on the left side, and their corresponding inputs and outputs on the right side. This final step is optional

because the main goal of this research is to propose a method that facilitates identifying and discussing ethical dilemmas during requirements elicitation. Logically, the actual solution to an ethical dilemma is a desired effect but not a goal in itself as ethical dilemmas cannot always be solved. Moreover, the company where the method is executed, is free to choose which ethical dilemmas should be solved in the first place as budget and/or time could limit the number of ethical dilemmas that can be solved.

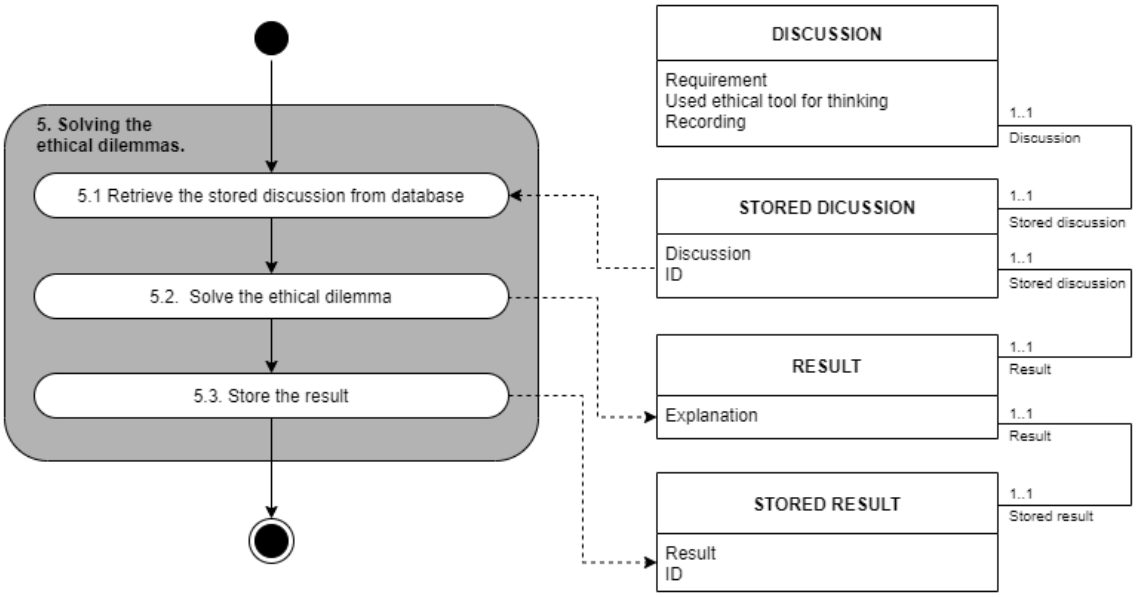

Figure 14. Detailed PDD of the solving step.

The first activity in this step is the retrieval of the discussion that is stored into a database during the previous step. Once this stored discussion has been retrieved, the main activity in this step can be started: solving the actual ethical dilemma. This should be done with the help of the retrieved stored discussion, which contains the requirement in which the ethical dilemma occurs, the ethical tool for thinking that has been used during the discussing, and the recording of the discussion itself. With all these artifacts in reach, the stakeholders should come to a conclusion on how the ethical dilemma should be solved. Once a solution has been figured out, the final activity in this step can be started. This activity is about storing the solution that has been figured out during the previous activity. Like the stored discussion used in the previous activities in this step, the solution can also be stored into a database in order to have safe storage and easy retrievability for archival purposes.

6 Method validation

With both the Problem Investigation phase and the Treatment Design phase completed, the Treatment Validation phase is the next step within the Design Cycle. This phase is needed in order to evaluate the proposed 5-step method in the previous chapter and gain understanding of the effectiveness and ease of use of the method. The first section of this chapter, section 6.1, explains how the validation is performed and the second section of this chapter, section 6.2, elaborates on the results of the validation.

6.1 Validation set-up

During a workshop called '*Ethics in Requirements Engineering*', part of the master course Responsible ICT at Utrecht University, the students participated in the validation of the proposed 5-step method. This course has 12 registered students and all 12 students participated in the workshop and finished the validation by means of an online survey through Google Forms. As a start, all students got an introduction to this research by means of a presentation and gained knowledge of how the proposed method is structured and which steps need to be taken in order to complete the method. After this introduction, the students were divided into four groups of three and received the same case, which is shown in Appendix 2.

Due to the relatively small sample size, a choice has been made to give all four groups the same case and have them end the workshop by means of a survey which focuses on giving qualitative results. This was done, because distributing two or more cases among the four groups would not yield any reliable results when compared as they would not be statistically significant, either with quantitative results or qualitative results. With the case handed out to all participants, all groups were asked to perform the same parts of the method within the time frame of the workshop.

Not all parts of the method were executed by the students. This was done because validating these parts of the method did not make sense during a case-based validation or were not possible due to the scope of the validation. However, this case validation was designed in such a way that the core contributions of the method were validated which have not been validated in previous literature. Table 7 shows which parts of the method were performed by the participants and which parts have not been performed, and why.

Table 7. Validated parts of the method.

Step	Validated	Clarification
1. Elicitate requirements.	Partly	Only, the third activity ('elicitate requirements') within this step was validated as activity 1 did not make sense during a case-based validation, and activity 2 would only be possible when requirements were elicited from people, not from a textual case. Activity 4 was omitted as this would only be useful in a real-life situation.
2. Identify the requirements where ethical dilemmas could occur.	Partly	Only the first activity is not validated as this activity is based on the output from the last activity of the previous step, which is omitted in this validation.
3. Discuss the ethical dilemmas.	Yes	This step was validated completely during the evaluation.
4. Storing the discussions.	No	This whole step is omitted as recording and storing the actual discussion into a database is not within the scope of this workshop setting.
5. Solving the ethical dilemmas.	Partly	Only the second activity is validated during this workshop, as the first and last activity are related to storing and retrieving the relevant information from a database.

Once the students have completed the case, they were asked to fill in a survey in order to gain insight into the usability and effectiveness of the method. The survey was created with Google Forms and is shown in Appendix 3. The results of this survey are elaborated on in the next section.

6.2 Validation results

In total, 12 students completed the case and the survey during the workshop, of which all results were sufficient in order to use for analysis. For all closed questions, a 7-point Likert scale was used. The age range of the students was between 22 and 25 and gender division between male and female was, respectively, 7 and 5. Looking at the results of the questions regarding the overall method, a strong support for the method can be seen as almost all respondents stated that the method is easy to use, understandable,

and is a useful addition to requirements engineering. One respondent mentioned the method being '*a useful contribution to requirements engineering as ethics is often overlooked*' (respondent 11) and another respondent stated that '*the method is easy to understand!*' (respondent 5). Furthermore, a respondent stated that '*it was very easy to do the steps by following this model. Every part was clear*' (respondent 12). Figure 15 shown the responses of three questions regarding the understandability, ease of use, and if the method is a useful contribution to requirements engineering, plotted into a bar graph. This figure reiterated the support of the method as aforementioned.

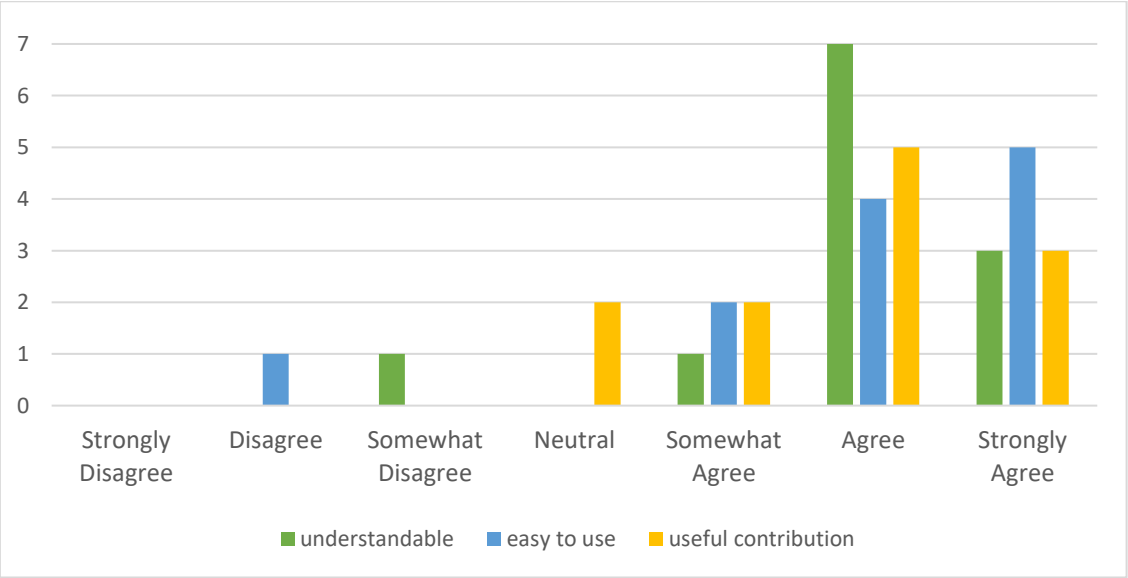

Figure 15. Partial results on the overall method.

Besides the three variables shown in figure 15, respondents were asked to rate how well the overall method makes recognizing, and discussing, ethical dilemmas possible. Again, a support for the method can be seen in the results of the survey. As one respondent said: '*It definitely helps with recognizing ethical dilemmas since you have to understand a certain point of view from a person with a role*' (respondent 4). This is further substantiated by respondent 10, stating that '*having these ethic themes available, based on actual literature research, could motivate Requirement Engineers to pay closer attention to ethics*'. Figure 16 shows the responses of two questions regarding how well the method helps with recognizing and discussing ethical dilemmas during requirements engineering. Again, this figure recapitulates the support of the overall method as mentioned before.

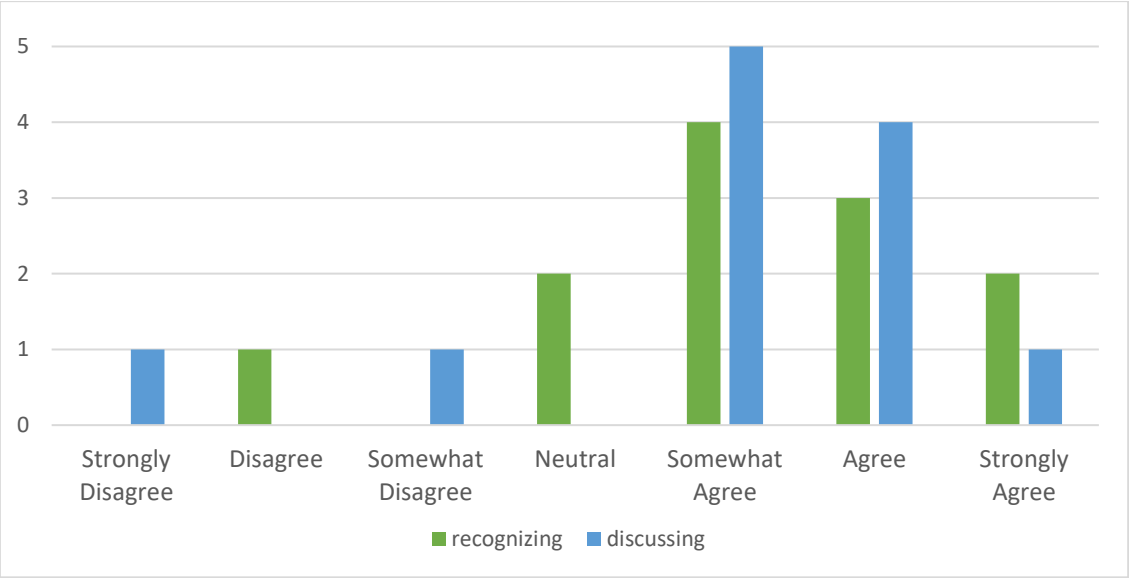

Figure 16. Partial results on the overall method.

Results from the five questions regarding the five individual steps from the method show the same support as the results regarding the overall method. For each individual step, two questions were asked: about the understandability and about ease of use. The figures of the results of these five questions are shown below. Figure 17 corresponds to the first step of the method, figure 18 corresponds to the second step of the method and so forth up to, and including, figure 21. For each individual step in the proposed method, a positive outcome of the survey is shown, as seen in each figure. On step 1, respondents mentioned that '*this is easy to understand and apply in practice*' (respondent 10) and that the '*steps are clear and well-formulated*' (respondent 2). Similar responses on ease of use and usability were given on the second step, where one respondent mentioned that this step is an '*easy step to follow*' (respondent 11) and another respondent said '*the steps are clear*' (respondent 9). Moreover, respondent 6 mentioned that '*the addition of the ethical themes table makes working with ethics and dilemma's, which can be vague, concrete'*, which is one of the goals of this research.

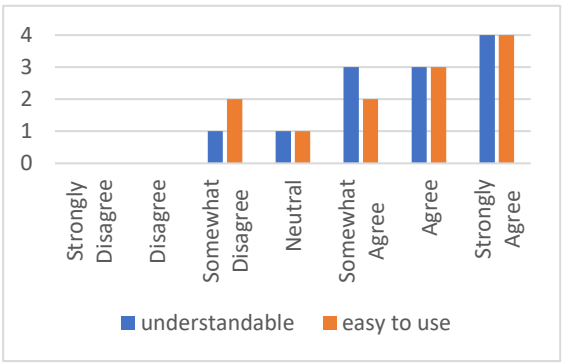

Figure 17. Results of step 1.

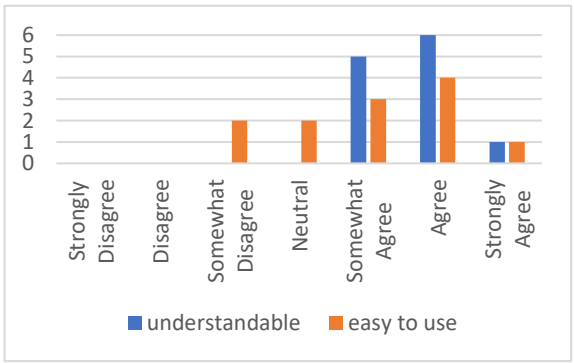

Figure 18. Results of step 2.

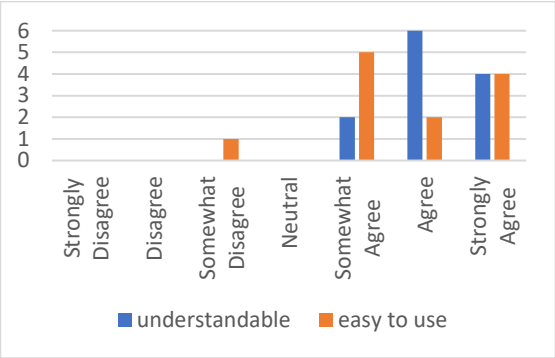

Figure 19. Results of step 3.

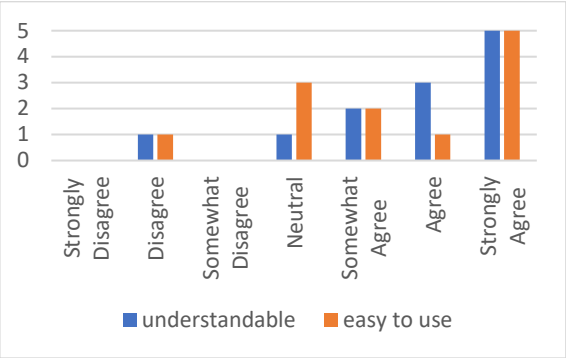

Figure 20. Results of step 4.

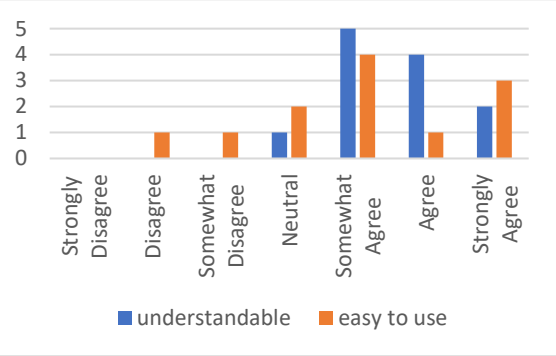

Figure 21. Results of step 5.

Regarding, the third, fourth and fifth step, results were also very positive when looking at the ease of use and understandability. Most respondents commented on how easy to execute the steps were and how understandable the steps were, as commented by respondent 12 on step four. She states that '*these steps are very clear and described well, which makes them understandable and easy to use*'. Another respondent mentioned that step three was '*easy to understand*' (respondent 10). On the last step, step five, respondents commented that '*this step is clear and concise*' (respondent 12) and that the step was '*easy*' (respondent 11).

Some respondents commented that certain activities within the steps were open to interpretation, leading to different interpretations of these actions. For example, the first activity from step 1, getting domain understanding, was not always clear to the participants. However, this activity was not part of the case during the workshop but only for the survey where questions were asked regarding the whole method, not just the activities that were part of the workshop. This led to some parts of the method not being fully clear. Based on the feedback, some parts of the method were slightly altered in terms of explanation, in order to make it more understandable.

7 Discussion & conclusion

In this finale chapter, we look into the meaning behind the results and discuss which limitations are present in this research. The validity of this research and results are elaborated upon and possible suggestions for future research are made. Section 7.1 will go into detail on these limitations, threats to validity and areas of future work. In section 7.2, the main contributions of this research are presented by answering the three research questions. By answering these three research questions, it will show how the main research goal of this research is reached.

7.1 Discussion

This research aimed to create a novel method that allows the recognition and discussion of ethical dilemmas during requirements engineering, more specifically, during requirements elicitation. The proposed five-step method has been constructed in such a way that requirements engineers should simply follow the method step-by-step, which results in fully discussed ethical dilemmas found in requirements. Optionally, these ethical dilemmas are also resolved. A limitation within this research is the list of seven possible ethical themes that could indicate if a requirement holds an ethical dilemma. These themes are found by means of an extensive literature study in combination with two expert interviews from the same company. Therefore, the list with common ethical themes could not be finite as other types of companies may cope with different ethical themes, but this list should provide a solid base on which possible new themes could be added.

A second limitation of this research is the use of two ethical tools for thinking while more tools could be in existence that can assist with the discussion of ethical dilemmas. Due to the scope of the research and the scope of the validation, no more than two ethical tools for thinking are incorporated into the method as example, as other ethical tools for thinking can easily be added to the method. While the validation of this method did not suggest that the current two incorporated tools were not insufficient, a validation with a larger sample size could perhaps uncover dilemmas or groups of stakeholders that are not well treated with these two tools. Therefore, a possible risk could exist that certain ethical dilemmas turn out to be difficult to discuss with the assistance of the current two ethical tools but could be discussed with a tool for thinking that is not currently implemented.

A threat to the validity of this research is the fact that the field of incorporating ethical thinking into requirements engineering, and more specific into requirements elicitation, is a very recent field of study. Only in the last couple of years, it has been stressed to start incorporating ethics into this field, which means that little research is currently

present. The common ethical themes within ethical dilemmas found during the literature study are based on papers that describe ethical themes in a variety of research fields and are not solely focused on the field of requirements engineering. There is simply too little research on ethical thinking within requirements engineering in order to solely use literature from that field. This means that, when looking specifically into requirements engineering, a different set of common ethical themes could exist. However, this can only be investigated when the field of the combination of ethics and requirements engineering is matured.

Moreover, the way the proposed method was validated, poses some threats to the validity. A relatively small sample size of 12 was used for evaluation, by means of a workshop combined with a survey at the end. Due to this sample size, a choice has been made to look into the results from a qualitative perspective instead of quantitative. No statistical analysis had been done because this would not be significant due to the small sample size. But even the qualitative results cannot be used to conclude with 100% certainty that the proposed method is effective, although it gives a good indication. Due to the fact that almost all participants were knowledgeable of requirements elicitation and the ethical tools for thinking, the results of the survey may be more positive than using participant that would not have full understanding of these ethical tools for thinking. Due to these possible threats to the validity, it is difficult to state with certainty that this proposed method is generalizable.

Based on the discussion above, there are some opportunities for future work. For example, when the combined fields of ethics and requirements engineering becomes more mature, a more detailed and extensive literature study can be conducted. By doing this, the current list of seven ethical themes can be better validated and because of that, a more accurate list of common ethical themes can be composed. This would enhance the validity of this list, which in turn provides a more accurate foundation on which requirements with possible ethical dilemmas can be recognized. If this combined field of ethics and requirements engineering does not mature in the foreseeable future, a different path for future work could be the validation of the current list by interviewing more expert on requirements engineering. Besides validating the current list, they could possibly also be able to extend the list with, in their opinion, other common ethical themes currently not found in this list of seven themes. In turn, these can be validated again by other experts in the field. Also, as scanning all relevant requirements for the possible possession of an ethical theme, future research can be done on expediting this process. For example, scanning the relevant requirements automatically on certain keyword may give a more narrowed down list of relevant requirements which the requirements engineering can scan by him- of herself.

A second opportunity for future works is a more extensive look into other ethical tools for thinking that could help with the discussion of ethical dilemmas within requirements. The current two ethical tools for thinking are usable for requirements that contain a

single ethical theme but are also usable for requirements that contain more than one ethical theme. However, research can be done on other ethical tools for thinking that may provide better assistance during the discussion of these ethical dilemmas. When this is indeed the case, a more diverse method can be constructed that could be better tailored to the specific situation when the current two ethical tools for thinking do not provide a good support during discussion. Even if these new ethical tools for thinking are not a better solution than the currents two tools that are incorporated, they could still be incorporated into the method. By doing this, a more complete method is created which can be applied to more situation where certain stakeholders may prefer a certain kind of ethical tool for thinking. In this way, the current method stays identical in terms of steps and activities, but the content of these activities could be better tailored to the specific context of a company where the method is being used.

Another possibility for future works is the validation of the complete method. As mentioned before, the sample used during validation gave very good qualitative results and responded positively to the method. However, the method could be further validated by, for example, giving more similar workshops to classes from similar courses across other universities. This would greatly improve statistical analysis of the results and could provide better insights into the effectiveness, understandability, and ease of use of the method. Another way to achieve a better validation could be to create a complete package of the workshop which can be executed without supervision or an introductory presentation, as this would be included in the package. By doing the validation in such a way, a large sample can be gathered by just sending the complete package by, for example, email. A final option could be to execute the method in real life scenarios at actual companies. By validating the method in such an environment, information can be gathered from the people who would actually use the method and therefore could provide valuable feedback. This, however, is a labor-intensive option and requires much planning.

Finally, an interesting thought could be the role of requirements elicitation itself when dealing with ethics and requirements engineering as requirements elicitation is a process where people play a key role. For example, certain requirement elicitation techniques that uses groups of some sort, may favors males as they make up the largest part of management functions. This could result in females becoming less vocal and therefor create possible ethical dilemmas. Other examples could be the use of techniques that frequently use numbers when some participants may have a math deficiency or the use of an elicitation technique that favors writing everything down while certain participants have a form of illiteracy. These kinds of possible issues raise the question if requirements elicitation on its own could lead to ethical dilemmas. An opportunity for future works could be to investigate if these issues do occur, how they influence the elicitation process, and if possible, solutions can be created to mitigate this problem.

7.2 Conclusion

The goal of this research was aimed at creating a method that supports in recognizing, and discussing, ethical dilemmas during requirements engineering. More specifically, during the requirements elicitation process. The foundation of this research was a literature study which focused on requirements elicitation techniques, choosing the right elicitation technique, recognizing ethical dilemmas, and discussing ethical dilemmas. Moreover, expert interviews were conducted in order to obtain validation for the seven common ethical themes found during the literature study. The results of this literature study and expert interviews were combined and transformed into a method that supports in recognizing and discussing ethical dilemmas. Finally, the proposed method was validated by means of a workshop, combined with a survey which was taken by the participants of this workshop. In order to reach the aforementioned goal, the goal was decomposed into three research questions, which will be answered below.

RQ1: How can ethical dilemmas be recognized and discussed during the requirements elicitation process?

The goal of this research question was to gain an understanding of how a possible ethical dilemma can be recognized during the requirements elicitation process and how this possible ethical dilemma can be discussed in order to possibly solve this dilemma. An extensive literature study was conducted on existing research, which focused on common ethical themes within ethical dilemmas. This study resulted in seven common ethical themes found within ethical dilemmas: *Individual vs. Group*, *Privacy*, *Difficulty*, *Lack of Resources*, *Lives*, *Security*, and *Fairness.* Using these common ethical themes as indicators for possible ethical dilemmas, elicited requirements can be scanned in order to find these common ethical themes. Once one or more themes are present in a requirement, this requirement can be marked as a requirement with a possible ethical dilemma. Expert interviews were conducted in order to validate if these ethical themes are indeed present during requirements engineering and whether more common ethical themes are in existence. These interviews confirmed the existence of the current seven common ethical themes and resulted in no other common ethical themes being identified. This list of common ethical themes within ethical dilemmas acts as a contribution to scientific literature as such a list, created by an extensive literature study and evaluated through experts interviews and a workshop, is currently non-existent and acts as a novel technique to recognize ethical dilemmas within requirements.

Furthermore, a literature study was also conducted in order to understand how these identified ethical dilemmas can be discussed in such a way, that it can help the stakeholders involved make a sound decision on how to possibly solve this ethical dilemma. The literature study resulted in selecting two existing ethical tools for thinking

that assist the stakeholders involved with their discussion in order to help them make a decision on how to possibly solves this ethical dilemma. The first ethical tool for thinking is the Square of Values. This tool can be used in the discussion of an ethical dilemma when only one ethical theme is present in the requirement as the Square of Values cannot incorporate two or more values in one figure. When two or more common ethical themes are present in a requirement, the second ethical tool for thinking can be used. This second tool is a table where three possible design solutions for an ethical dilemma are placed. The first solution is suggested without any prior knowledge gain, the second suggested solution is given after an ethics workshop given by an expert. The third, and final, solution is a so-called regulative idea which is an idealized solution. By incorporating these three possible solutions into the table, a discussion about ethical dilemmas can be made easier as these solutions act a guideline for the ones making a decision on how to possibly resolve the ethical dilemma. While this ethical tool for thinking can be used for requirements where only one ethical dilemma is present, the Square of Values is the preferred option. This is due to the fact that the Square of Values takes significantly less time to execute as the table with the three possible design solutions, as that option needs an ethics workshop given by an expert.

RQ2: Which requirement elicitation techniques are suitable for the support of recognizing and discussing ethical dilemmas?

This research question was devised in order to gain knowledge about which popular elicitation techniques are currently in existence and how these elicitation techniques can be chosen during the first step of the proposed method, which is about eliciting the requirements. An extensive literature study was conducted which resulted in a list of 15 popular elicitation techniques. The proposed 5-step method has the possibility to incorporate all of these 15 elicitation techniques, as the goal of this method is to be applicable within any company. Therefore, the main steps and activities within this method are generalized and thus allows all elicitation techniques to be used, but the actual activity of eliciting the requirements can be tailored the context of a specific organization. However, choosing which elicitation technique, or techniques, to use can be difficult for a requirement engineer as each company is different and may or may not be compatible with a certain elicitation technique. For our proposed 5-step method, a technique selection method is incorporated that is elaborated upon in section 3.1.2 and can be seen in figure 5. With the assistance of this method, a requirements engineer has the possibility to select the right elicitation technique, or techniques, which are suitable for that company's specific context.

RQ3: How can ethical dilemma recognition, and discussion, be combined with elicitation techniques into a method?

The goal of this research question was to combine the knowledge gained by the previous two research questions in order to create a method which provides a step-by-step instructions that support the requirement engineering and the stakeholders of a company with recognizing and discussing ethical dilemmas that arise during requirements elicitation. Based on the knowledge gained by RQ1 and RQ2, a 5-step method was created and visualized with PDDs. These five steps are: 1. *Elicitate requirements*, 2. *Identify the requirements where ethical dilemmas could occur*, 3. *Discuss the ethical dilemmas*, 4. *Storing the ethical dilemmas* and 5. *Solving the ethical dilemmas*. The intend of this method is to be generalized in such a way that each company that uses the requirements elicitation process, can apply this method within their company and tailors to the specific context of a company. This 5-step method is the main contribution of this research to scientific literature as no concrete method currently exists in literature that incorporates ethical thinking into requirements engineering, done by providing step-by-step instructions to recognize and discuss ethical dilemmas found in requirements and possibly solve these ethical dilemmas. This method was validated by a workshop where the participants were asked to complete a case and fill in a survey once they finished the case. The outcome of this validation showed a strong support for this novel method.

In conclusion, two contributions have been made to scientific literature. First, a list has been compiled consisting of seven common ethical themes which exists in ethical dilemmas. Second, a 5-step method has been created that supports in recognizing, and discussing, ethical dilemmas found during requirements elicitation.

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Appendices

Appendix 1 – Interview template

Due to the Covid-19 pandemic, interviews were held through the use of video chat or regular phone calls.

First, a general introduction to this thesis and its main topics will be given in order to help the interviewee to fully understand what the interview was about and its intent. Also, basic questions are asked in order to get a demographic overview of the interviewees. These questions are:

1. What is your name?
2. What is your position in the company you are working at?
3. How many years of experience do you have in your position?
4. Do you give permission to let the interviewer use the answers of this interview in this thesis and this thesis only?

Second, in a random order, each ethical theme found in table 4 of section 5.3 is introduced. After each introduction, the following question will be asked: 'Do you believe that this ethical theme is common in requirements engineering?'. If a simple yes/no answer is given, the interviewee will be asked to elaborate on his/her answer. The ethical themes are introduced in random order, which prevents that each interviewee will give long answers for the same ethical theme in the beginning of the interview and short answers for the same ethical theme at the end of the interview, as it is common that interviewees tend to shorten their answers as an interview progresses. Open answers instead of closed multiple choice answers were chosen in this interview protocol as the most detailed answers possible is needed in order to fully understand if the chosen common ethical themes are correct and why, or why not. After the question, the interviewee is asked if they perhaps know another common ethical theme that occurs frequently in requirements engineering that was previously not mentioned.

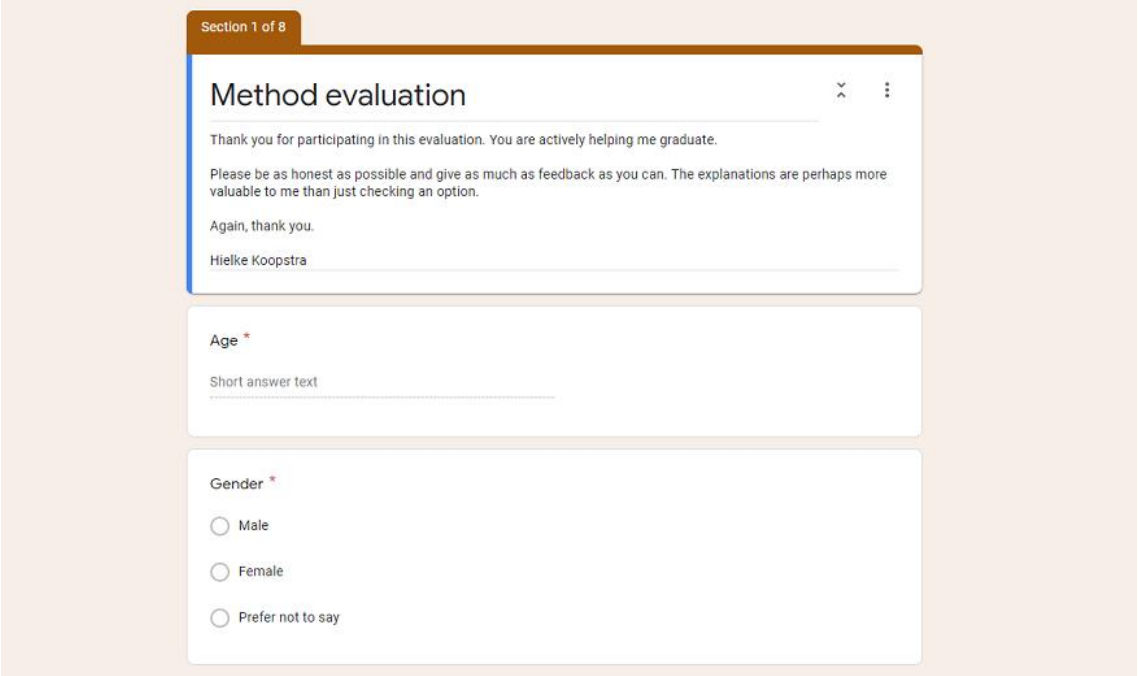
Appendix 2 – Case for workshop

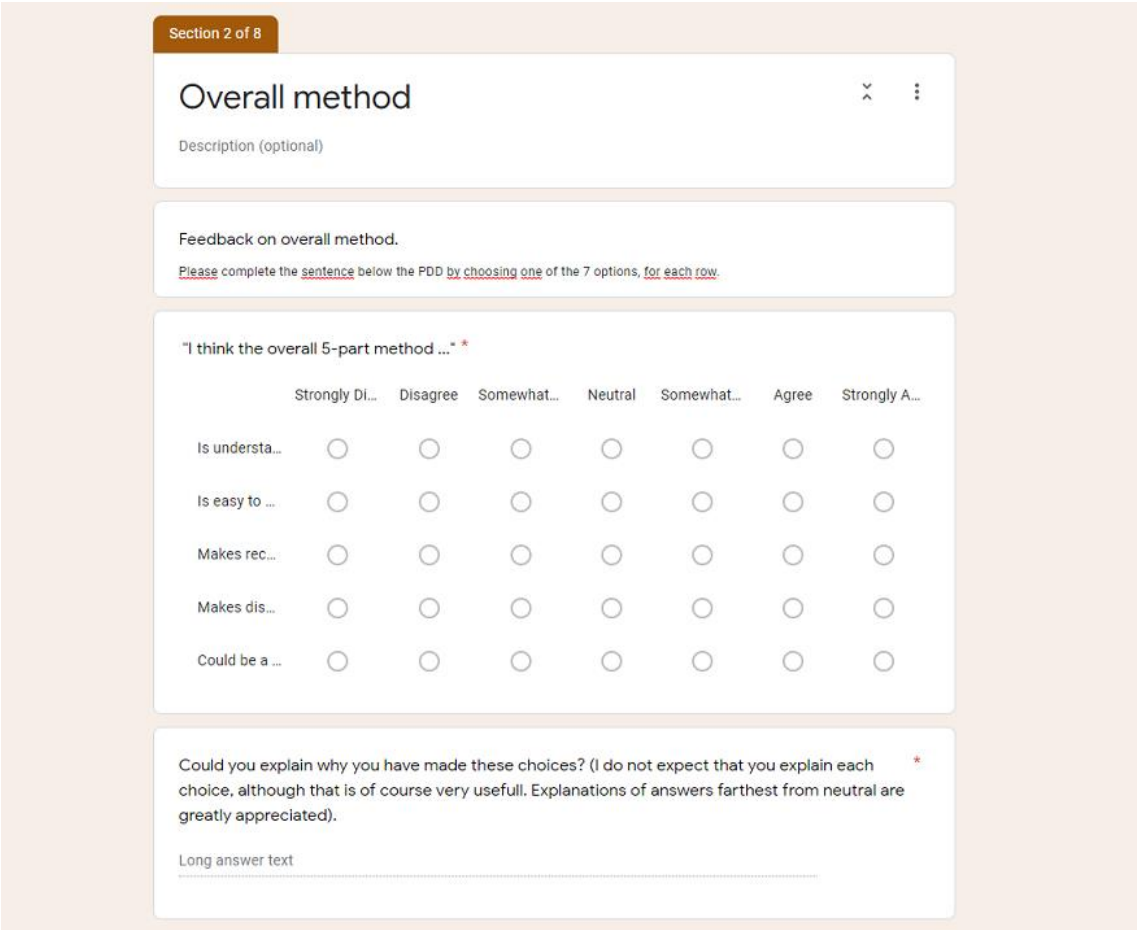
A large hospital is looking for a new software system that can assist nurses with monitoring their covid-19 patients from a distance. With this system:

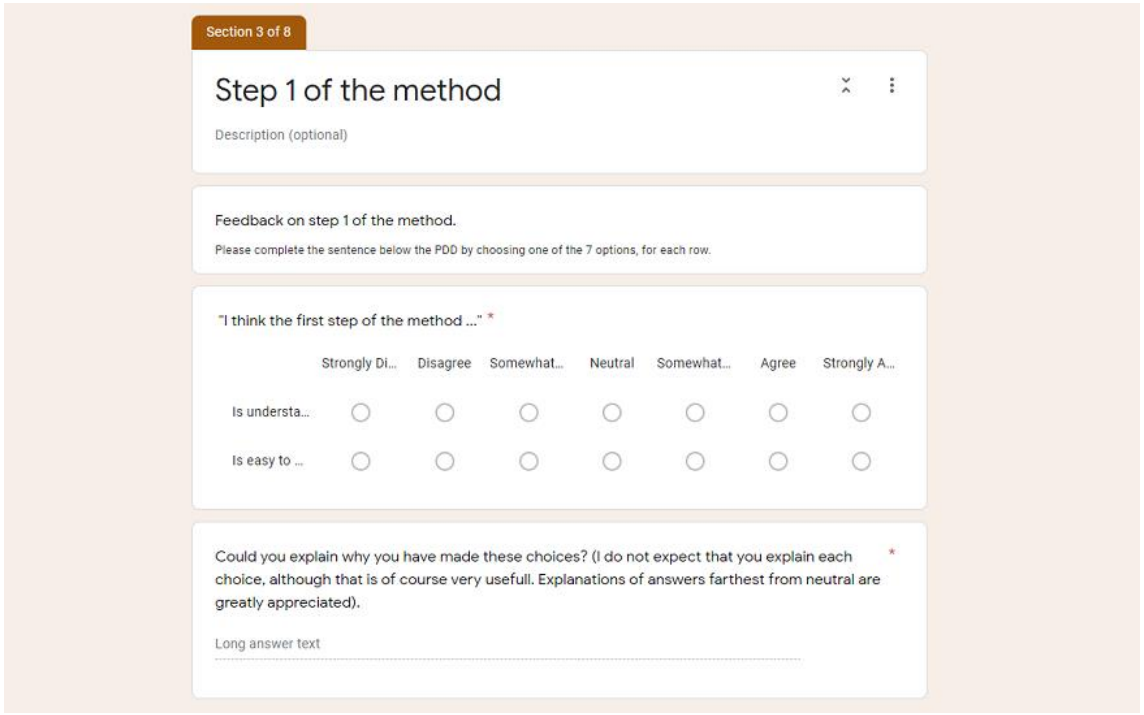
- Nurses should be able to monitor their patients from a central control room which limits the amount of contact between nurse and patient. The nurses also need an alarm system, which activates if any of the monitored parameters goes above a certain threshold.
- Patients should get monitored without having to much interference from the system, so it does not harm them in any way. Furthermore, they should be able to let the nurses know if they are in need for a nurse close to them for whatever reason.
- Managers can see in an instant how each monitoring system in each room is performing and how al monitoring systems are performing in total. For example, they can see how many times parameters are above a certain threshold and how many times a patient requests a nurse.
- Developers should be able to add or remove parameters for monitoring and change the threshold of these parameters. Furthermore, they need to be able to change how managers see the status of each monitoring system and all systems in total.

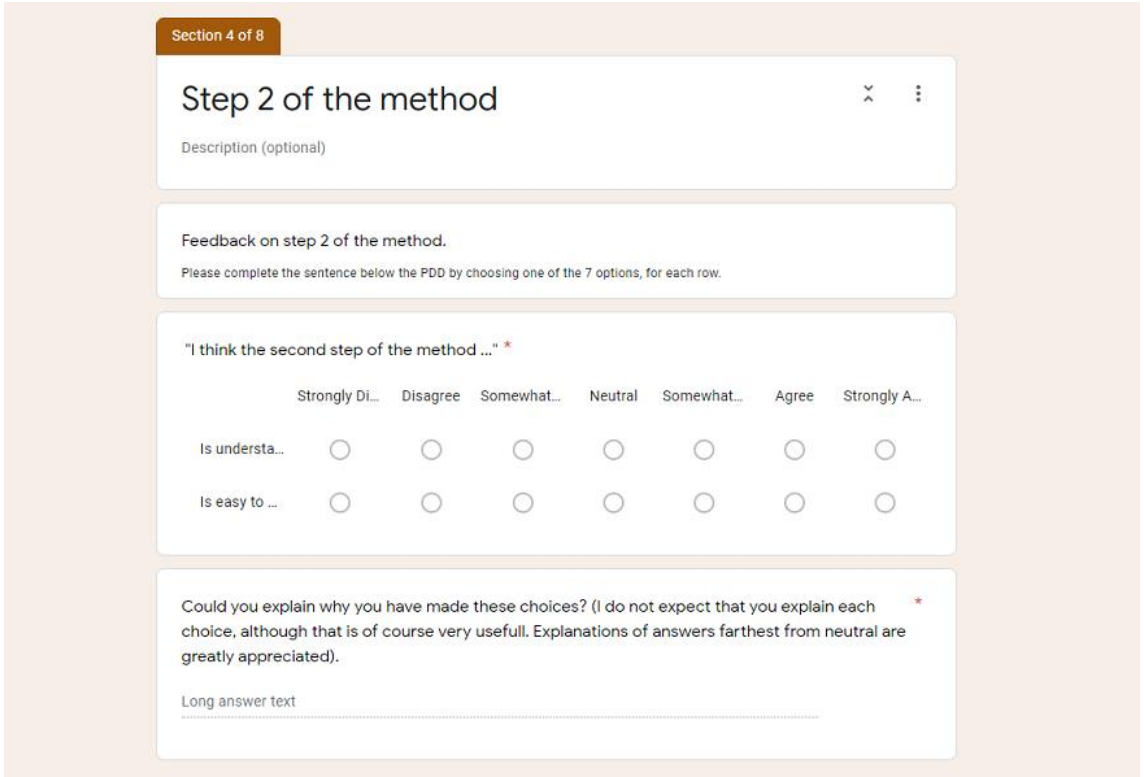
Appendix 3 – Survey for workshop

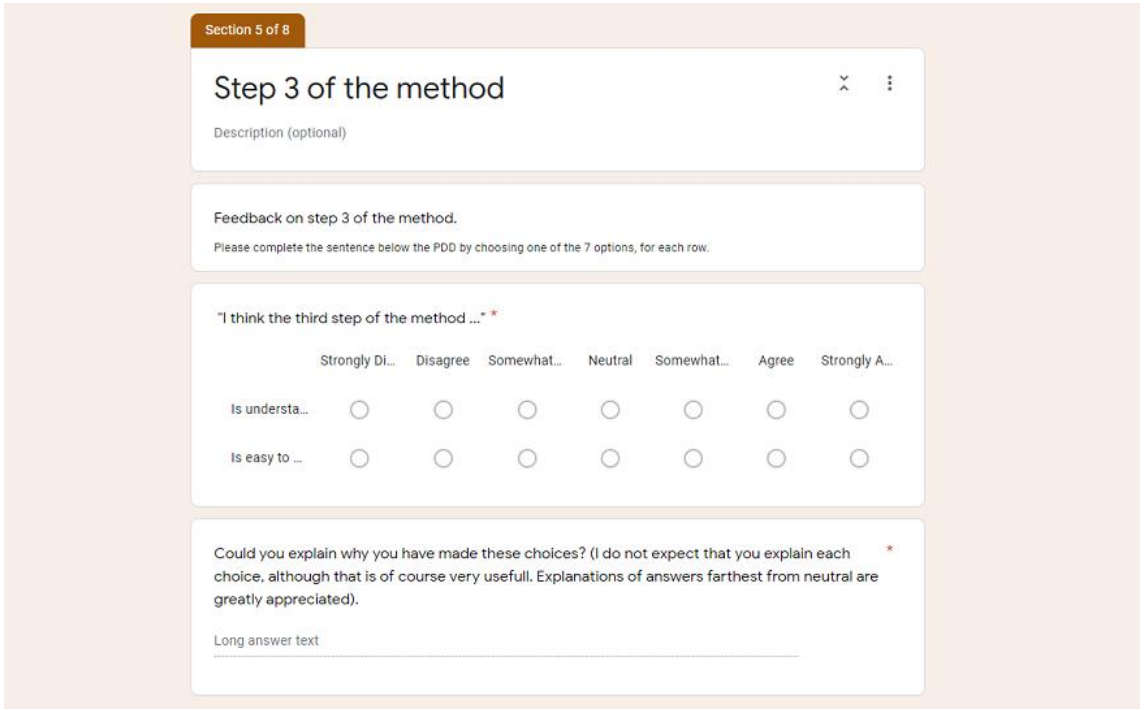
The survey, used during the workshops as a means of evaluation, consists of 8 sections. Please note that the PDD have been omitted from these screen captures due to their size.

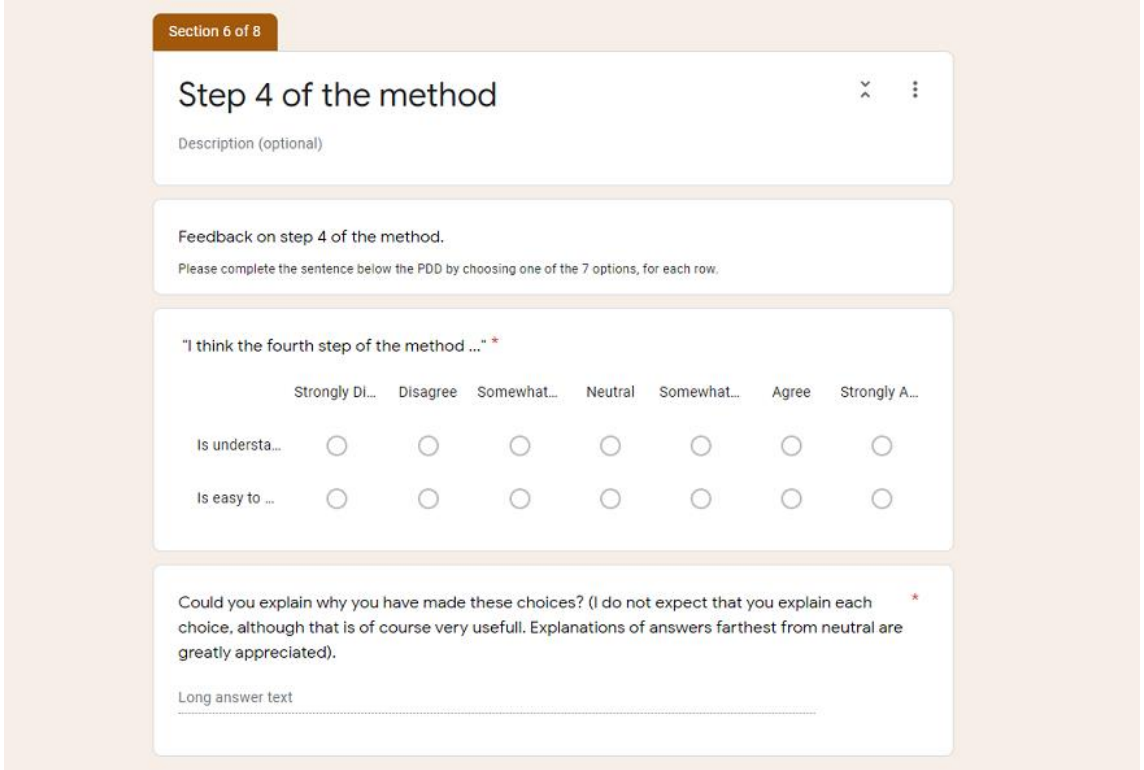


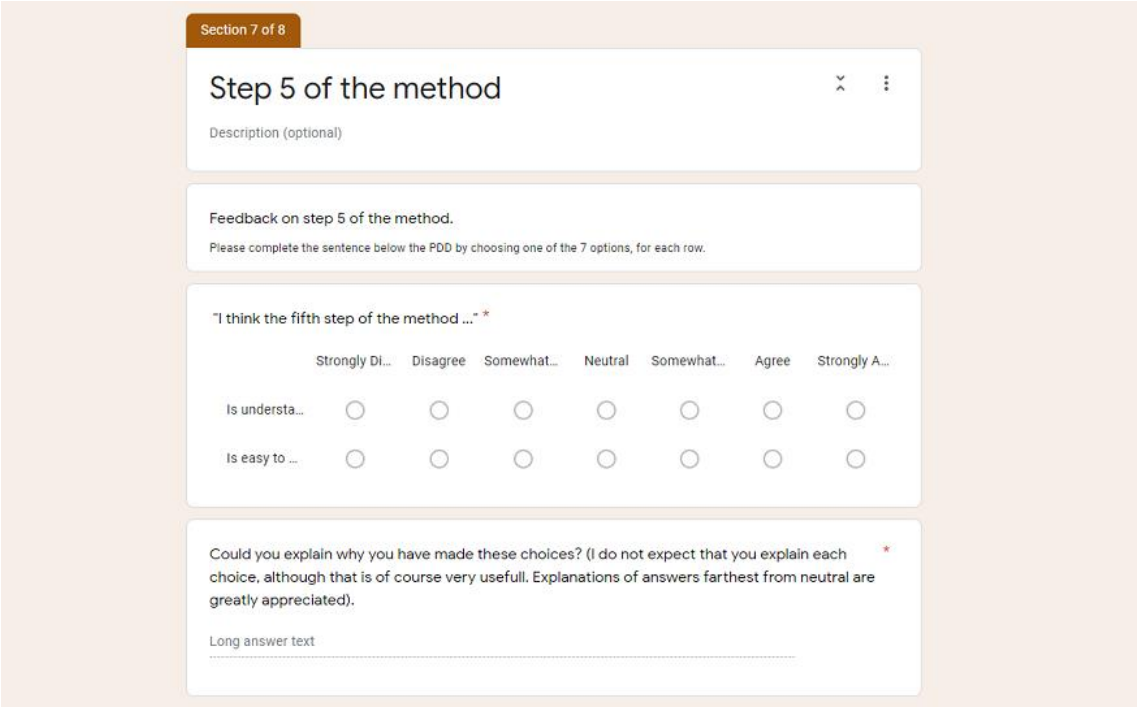


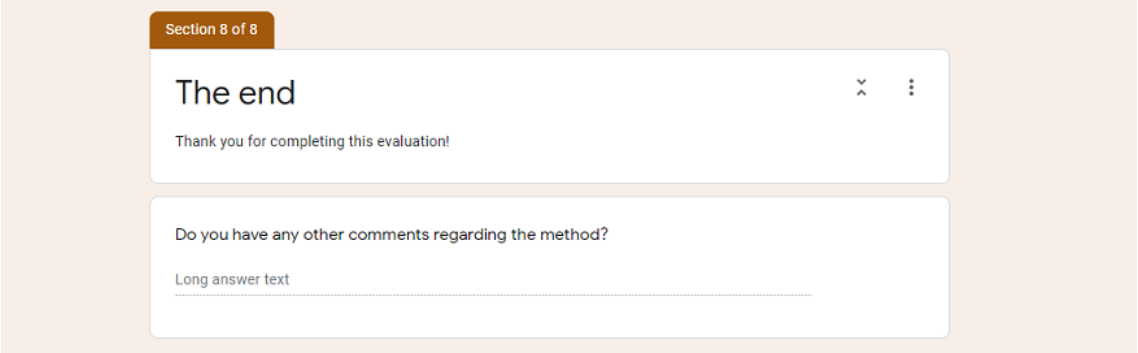

Section 3 of 8
Step 1 of the method
Description (optional)
Feedback on step 1 of the method.
Please complete the sentence below the PDD by choosing one of the 7 options, for each row.
"I think the first step of the method ..." *
Strongly Di...
Disagree
Somewhat...
Neutral
Somewhat...
Agree
Strongly A...
Is understa...
Is easy to ...
Could you explain why you have made these choices? (I do not expect that you explain each choice, although that is of course very usefull. Explanations of answers farthest from neutral are greatly appreciated). *
Long answer text


Section 4 of 8
Step 2 of the method
Description (optional)
Feedback on step 2 of the method.
Please complete the sentence below the PDD by choosing one of the 7 options, for each row.
"I think the second step of the method ..." *
Strongly Di...
Disagree
Somewhat...
Neutral
Somewhat...
Agree
Strongly A...
Is understa...
Is easy to ...
Could you explain why you have made these choices? (I do not expect that you explain each choice, although that is of course very usefull. Explanations of answers farthest from neutral are greatly appreciated). *
Long answer text


Section 5 of 8
Step 3 of the method
Description (optional)
Feedback on step 3 of the method.
Please complete the sentence below the PDD by choosing one of the 7 options, for each row.
"I think the third step of the method ..." *
Strongly Di...
Disagree
Somewhat...
Neutral
Somewhat...
Agree
Strongly A...
Is understa...
Is easy to ...
Could you explain why you have made these choices? (I do not expect that you explain each choice, although that is of course very usefull. Explanations of answers farthest from neutral are greatly appreciated). *
Long answer text


Section 6 of 8
Step 4 of the method
Description (optional)
Feedback on step 4 of the method.
Please complete the sentence below the PDD by choosing one of the 7 options, for each row.
"I think the fourth step of the method ..." *
Strongly Di...
Disagree
Somewhat...
Neutral
Somewhat...
Agree
Strongly A...
Is understa...
Is easy to ...
Could you explain why you have made these choices? (I do not expect that you explain each choice, although that is of course very usefull. Explanations of answers farthest from neutral are greatly appreciated). *
Long answer text


Section 7 of 8
Step 5 of the method
Description (optional)
Feedback on step 5 of the method.
Please complete the sentence below the PDD by choosing one of the 7 options, for each row.
"I think the fifth step of the method ..." *
Strongly Di...
Disagree
Somewhat...
Neutral
Somewhat...
Agree
Strongly A...
Is understa...
Is easy to ...
Could you explain why you have made these choices? (I do not expect that you explain each choice, although that is of course very usefull. Explanations of answers farthest from neutral are greatly appreciated). *
Long answer text


Section 8 of 8
The end
Thank you for completing this evaluation!
Do you have any other comments regarding the method?
Long answer text