The Role of Moral Emotions among Software Engineers in Value-Decisions during Engineering Design phases

An Exploratory Study

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Abstract

Emotions and moral values have gained attention in recent researches in philosophy and ethics of engineering. This is due to its usefulness in assessing the technological risks imposed towards its user or society. Furthermore, moral emotions assist in reflection of moral values and research stress upon involving emotions in design practices. Moreover, researchers argue that engineers are the people who spend the most time with the development of technology. Thus, they must consider their emotions to influence moral values to mitigate risks that are associated with the technology. However, to what extent this prevails among engineers was not clear. Thus, through the use of semi-structured interviews with software engineers, this exploratory research shows the absence of awareness of the usefulness of moral emotions among engineers. The findings also showcase the perception of software engineers towards the involvement of moral values as something insignificant in the design practices. Lastly, this research recommends acknowledging the emotional responses of engineers by the management, training engineers as virtue ethicists and encouraging imaginative capacities and drawing attention to values for engineers during engineering design phases.

Executive Summary

Engineers view themselves as a rational and quantitative bunch of people who see the world with formulas and numbers. Furthermore, engineers' responsibilities are limited to dealing with the technical side of technology. At the same time, the assessment of possible consequences, for better or worse, is left to policy-makers and management. Scholars stress upon the inclusion of moral values in engineering design phases to mitigate any unintended risk that technology might impose to its users and society. Instead of leaving the inclusivity of moral values to policy-makers and experts in the field of risk assessment, the engineers should themselves be aware of and cultivate their moral assessment during engineering design phases as they are in way better position to mitigate risks and include moral values due to their presence in engineering design phases. Moral emotions can be a valuable source for receiving insight into the ethical side of the risks of technologies (Roeser, 2012). Therefore, engineers should include their moral emotions to develop value-laden technologies.

The necessity of moral emotions does not undermine the quantitative side of risk assessment. To the contrary, moral emotions add value to the risk assessment by enabling us to envisage future scenarios and take actions accordingly (Roeser, 2012). Moral emotions should be necessary to form well-grounded insights to assess whether a technological risk is morally acceptable or otherwise. This also can be translated to the necessity of moral emotions to evaluate the moral values that should be infused with technological development. Since technological development is an iterative process encompassing several design phases and involves almost only the engineers, I believe that the engineers should have an awareness of the necessity of moral emotions.

The origins of this research lie on the claims above of emotions being perfectly reasonable and rational to the moral judgement of technological risks. The assumption here is that since technological developments

happen in several phases, there are bound to be certain moments where decision-making is accomplished by various stakeholders, in which it was further assumed that engineers should be playing prominent roles. The objective of this research was to analyse the extent of the role of moral emotions during moments of value-decisions. The main research question was as follows:

What is the role of moral emotions for engineers in the engineering design phases during the moments of value decisions in engineering design?

In order to answer the questions above, the following sub-research questions were formulated.

1. Which emotions are experienced by engineers and in which context?
2. Which are the moments that the engineers should experience moments of value trade-offs?
3. How do engineers perceive the significance of their emotions in influencing moral values?

The samples in this research were the software engineers working for software engineering companies, and data were collected using semi-structured interviews. Nine engineers agreed to participate in the interview comprising of 15 questions. The interviews were performed digitally in consideration with the COVID-19 pandemic, and the transcripts were created using online tools known as *otter.ai*. Following a few modifications such as manually correcting misinterpreted words/phrases/sentences, the transcripts were analysed using the software package *atlas.ti*, a powerful tool for qualitative data analysis. Due to the qualitative nature of data, the analysis followed an iterative process wherein the data was looked upon after each cycle of coding and categorisation. Some interviewees were also contacted for clarification purposes concerning their responses during the initial interview.

The findings of the research were as follows. The interviews showed that most of the interviewees were unable to view emotions as a viable source of reflection for morally acceptable values. This was because contrary to the new approaches of emotions provided by researchers, engineers still hold rationality over sentiments, even in decision making for values. Furthermore, hierarchy, company culture, and code-of-conduct/company values were a few restraining factors that were found to restrict the role of moral emotions of interviewees during moments of value decisions in the design phases.

Researchers have encouraged enhancing context-sensitivity in the design of technology, which requires moral emotions. This kind of sensitivity in the design process should encourage engineers to use their moral emotions for value decisions, which includes value trade-offs as well. Furthermore, it is also recommended that the role of moral emotions can be more prominent by encouraging engineers to increase their imaginative capacities as well as drawing attention to maximizing positive values and minimizing negative values. Lastly, it is also recommended to include engineers during the discussion of values instead of merely providing them with the responsibility for technical values. By having such responsibility, it should be possible for engineers to realise the significant role of moral emotions in engineering design.

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1. Introduction

This chapter aims to familiarise the readers with the topics of interests and state-of-the-art encompassing in this research. Moreover, subsequent sub-chapters will introduce research objectives, questions, strategy and a route map to the rest of the content of this document.

As someone who has a passion for cinema, the researcher requests the readers to recall the story of Jurassic Park. In the film, a billionaire John Hammond builds a dinosaur-based theme park with the help of advanced genetic modifications performed by a group of scientist and engineers. His intentions are quite noble, meaning he intends to let humanity witness a glimpse at an era 65 million years in the past, irrespective of anyone's economic backgrounds. He pushes his team of engineers to develop dinosaurs through genetic engineering, without thoroughly analysing the ethical, moral and technical risks associated with the scientific progress. From the discussions within the film, the audiences learn how those engineers were able to use the DNA of frogs to fill the gaps of dinosaurs' genes. It was shown, albeit implicitly that the engineers were driven by their pride, greed and desire to be a part of enormous scientific progress, and created an all-female fleet of dinosaurs in both carnivorous and herbivorous categories. However, it was these emotions that led them to ignore the fact that their chosen species of frogs could spontaneously change sex, allowing a female to transition into a male for reproduction purposes, which happens with the dinosaurs as well resulting in uncontrolled population increase on the island. Another group of engineers responsible for setting up the security and protection systems for the visitors from the dinosaurs also failed to analyse potential threats and risks such as the creatures harming the visitors in case of technical failure.

The failure eventually happened because one character's greed and dissatisfaction led to the collapse of protection systems, leading to several

human casualties. The film depicted the implication of failure to recognise the ethical limit behind the scientific progress, scientist and engineers being inconsiderate about the values in their engineering development and how their own emotions led into a collision of two species separated by 65 million years of evolution.

Several questions arise as follows.

What if those engineers were more inclined to reflect upon what they were doing and asked themselves whether they should, instead of focusing on whether they could?

What if those engineers, instead of being rational, calculative and value-neutral, were emotional towards their scientific progress; and not just any emotion, the emotions which would let them take into account moral values?

Finally, what if they involved their moral emotions for gaining insight into their moral responsibilities, thereby thoroughly evaluating the technical and ethical considerations of the scientific progress and mitigating the risky elements in the due process?

The example provided above can be considered quite extreme, but the aforementioned questions hold even to this day. Technological progress has enabled humanity to evolve significantly in recent years. Today, we can travel around the globe quite safely, our healthcare and hygiene systems have witnessed enormous progress, and we live in an increasingly connected digital world where communicating with anyone around the globe happens in a matter of seconds. Furthermore, progress in automation, artificial intelligence and robotics have made manufacturing, production and supply chain easier than before. Overall, the technical developments have led our world to be healthier, safer and more efficient.

However, there are negative aspects of technological development, such as risks. E.g. breach of privacy, autonomy and data in the digital world, loss

of jobs due to automation, and increased level of pollution in the manufacturing world are risks that are undefined consequences of the technological development. The above are a few examples of risks assessed through quantitative methods such as cost-benefit analysis. However, a risk is not just a quantitative notion. Such methods fail to recognise the full extent of unwanted consequences because they do not consider ethical aspects such as whether the risk was taken voluntarily, the extent of distribution of risk on the population among others (Roeser, 2012).

For the designers and developers of the technological product or service, accounting for human values in the technology can facilitate mitigation of potentially adverse effects of technologies. The process is known as value-sensitive design and scholars emphasise that accounting for values should happen during the design phases (Friedman et al., 2017). Roeser argues that awareness of moral saliences is required to be able to provide a sufficient account of values because technological risks also contain ethical considerations (Roeser, 2012). There might be several methods to achieve awareness of moral insights, and one of the indispensable sources of such insights are moral emotions (Roeser, 2012).

Moral emotions help us to extend our concern capabilities (Nussbaum, 2001). For example, sympathy, fear, empathy are emotions which let us reflect on the perspectives of others. Roeser therefore, argues that these moral emotions are based on reasons and, they are needed to obtain moral awareness of the risky aspects of the technologies. As mentioned earlier, the ethical aspects of risk can be mitigated by accounting for values in the design of technological products. Therefore, moral emotions should be useful to involve moral values in the design of technological product or service.

Engineers have the capabilities to influence the development of a technological product because they are the frontrunners of technological design. In an engineering curriculum, engineers are trained to perceive the superiority of computational intelligence. The notion leads engineers to

suppress their emotional or narrative intelligence which results in lack of capacities to make moral judgements about technological risks (Roeser, 2012). Therefore, an argument can be made towards the inclusivity of emotional awareness among engineers because emotional sensitivity can provide engineers with access to aspects which are morally significant in their design (Roeser, 2012).

The responsibility of moral decision-making can be delegated to managers or policy-makers to help engineers to account for values. Alternatively, the presence of value-advocates, i.e. individuals designated with selecting designs that have a rationally and theoretically justified moral import, can also be beneficial for the design team (Manders-Huits & Zimmer, 2009). However, this is not a pragmatic solution because value-advocates can assume an authoritarian role which could lead to confrontation with other stakeholders whose interest might conflict with inclusivity of values (Manders-Huits & Zimmer, 2009).

Roeser states that managers and policy-makers will conduct moral decision making at the end of product development (Roeser, 2012). It is more efficient to let morally responsible engineers reflect upon the values that they perceive is essential to mitigate potentially risky aspects during the design phases. Given the claim that moral emotions are a valuable source for gaining insights into the moral reflection of technologies, engineers should let their moral emotions play a role during the engineering design phases of a technological product or a service.

So far, I have argued that emotions are a useful source to gain moral insights and that engineers should use them to form well-grounded evaluation about potentially risky elements and therefore, influence the design of the product or service. It is, however, also correct that the theoretical concepts on emotional reflection to influence moral values in design remains to be tested in a real-life context. This thesis intends to narrow down the gap between the above theoretical constructs and the extent of the role of moral emotions among engineers. Additionally, the

thesis also intends to determine the extent of moral awareness present among the engineers and if present, to what extent the awareness influences the moral values in engineering design phases. However, it is also essential to understand that not every value in existence can be involved in the engineering design phases of particular technological product development. Trade-offs among values are required to accomplish the well-grounded distribution of the risk and benefits of the product or service. Trade-offs occur when having one desirable value, requires giving up another desired value (Gregory, 2002). These trade-offs should be experienced through several moments of value-decision during the engineering design phases. This thesis intends to investigate the extent of the presence of engineers during these moments and whether their emotional experience during these moments plays a role in influencing the decision-making process. Furthermore, this thesis shall focus only on software engineers as a population because of several reasons.

1.1 Software Engineering

The exponential rise of technologies, especially in the field of internet-based services and products, and software design contain potential risks of fairness, autonomy and justice, among others. Software engineering is one of the most innovative industries. Continuous progress in innovation is preceded by complicated knowledge exchange among engineers which gives rise to design processes.

Moreover, the technologies directly or indirectly affect almost everybody as digitisation is on the rise. In terms of numbers, there are around 4.57 billion active internet users, with over 4.17 billion unique mobile internet users as of July 2020 (Statista, 2020). This number accounts for a 53.6% rise from 2005 (ITU, 2020). Going along just with social media, which accounts for less than 0.004% of the accessible internet (Purdon, 2019), there are around 3.96 billion active social media users around the world (Chaffey, 2020), which makes social media platforms the largest one to affect the users. Technologies such as automation, machine learning, artificial intelligence, internet-of-things, and cloud-computing are showing tremendous growth. These technologies have already begun to affect the lives of the laypeople through digital voice assistants, smart homes, ride-sharing services and data analytics among countless other ways (Gray, 2018). These technologies have positively reformed society by offering significant improvement in education, learning, healthcare, transportation, governance and countless other uses. However, along with the advantages, there are various risks associated with these technologies, and these risks will inevitably affect the lives of billions of users. Hence, engineers who are responsible for designing and developing these technologies should be aware of the morally acceptability of these risks. Value-laden technological development should motivate engineers to cultivate their moral emotions during engineering design phases. As a result, moments of value trade-offs are unknown, which means the

emotional experiences of the engineers during those moments are also unknown.

Value trade-offs can also be observed when we see an existing product with new improvements. For instance, another recent trend is the rise of dark mode on desktop-based web browsers and mobile-based applications. The dark mode is advantageous and increases public acceptance because of the positive polarity, meaning white text on black background results in less strain to eyes and facilitates in catching details effectively (Arielle Pardes, 2019). Facebook has also launched dark mode on its products, WhatsApp and Instagram in order to reduce eye strain and increase readability and information hierarchy for their users (Facebook, 2020). We see that the value of comfort for users was given priority in comparison to aesthetic value, which is value trade-off and should have happened during the design process. The example above can be expanded to Facebook, enhancing the protection of privacy of its users, while also allowing businesses to market their services based on user activity, a value trade-off among privacy vs exposure.

Considering the real observations of values inclusivity and trade-offs in the above examples, inviting software engineers as participants for this research makes sense because they can provide valuable input with their perception on usefulness of emotional reflection to influence value decisions and trade-offs.

1.2 Research Gap, objective and questions

The research objectives of this thesis are as follows. Firstly, the objective is to explore the extent to which engineers working in software engineering companies experience moral emotions during the moments of decisions where value conflicts and value trade-offs are faced. The second objective is to explore the perception of those engineers about their perception of emotional reflection and its role in influencing moral values during design phases. The objectives translate to the following research questions:

What is the role of moral emotions for engineers in the engineering design phases during the moments of value decisions in engineering design?

In order to answer the questions above, the following sub-research questions are formulated.

1. Which emotions are experienced by engineers and in which context?
2. Which are the moments that the engineers should experience moments of value trade-offs?
3. How do engineers perceive the significance of their emotions in influencing moral values?

1.3 Research Design

A research design is a map created to collect, measure and analyse the data through which a researcher will be able to answer the research question(s) (Sekaran & Bougie, 2016). The quality of the research and its outcomes depends upon the critical choices of the researcher concerning objectives, questions and limitations of the research. A researcher must also appropriately choose the method of data collection and analysis as well as the sampling design. All of the decisions described above together constitute a research strategy. In the following sections, namely 1.3.1 and 1.3.2, provides a brief overview of the research strategy and data collection method designed for this thesis. In chapter 3, a detailed overview of the research methodology is provided.

1.1.1 Research Strategy

A research strategy assists in meeting the research objective(s) as well as in answering research questions of the study (Sekaran & Bougie, 2016). Depending upon the questions, research can be categorised as either exploratory, descriptive or causal. An exploratory research question is developed when there is little information about a particular phenomenon, suffers from limitations, or lack of theory to develop a theoretical framework. The primary works of literature that this thesis is based provided normative arguments about the influence of emotions on value decisions and therefore suffers from a lack of empirical investigation. Hence, this research is categorised into an exploratory study. Furthermore, exploratory research questions are answered by using qualitative methods, for instance, through the use of interviews or focus groups as instruments of data collection.

1.1.2 Data Collection and Analysis

The first phase of data was collected using the existing literature in order to develop familiarity with the topic. As defined by Sekaran & Bougie

(2016), a literature review is beneficial for the rigour of the study (Sekaran & Bougie, 2016). The literature review provides an overview of all the existing research and the adopted research methods by the authors on that research.

Semi-structured interviews are selected when a researcher knows what to explore, and has a set of questions prepared for the interview, although the conversation is free to vary and could change depending on the participants (Miles & Gilbert, 2005). The advantage of a semi-structured interview is that it allows a degree of freedom to the interviewees to express their opinions and flexibility to obtain information on some underlying motives as well (Lowe, 2005). A set of 13 questions were created, among which a pair of them were alternatives to each other. This means that depending upon the interviewee's answer on the above question, one question between the two was asked. The interviewees were randomly selected through the use of LinkedIn and through snowballing, the only criteria being that they were software engineers by profession, working for technology companies. Every potential participant received a personalised invitation with a summary of the research objective. After their acceptance as a participant, an appointment was made for the interview, which was recorded, transcribed and analysed from which meaningful conclusions were generated. All of this is detailed in Chapter 3.

1.4 Relevance

The knowledge obtained from this study will contribute to the scientific community and businesses. In an engineering context, engineers should be involved in value decisions for their technology as they are critical stakeholders in technological development. They can use their emotions balanced with rationality to involve ethical and moral values in engineering (Roeser, 2012). Thus, this research will add weight to the normative argumentation by exploring the thoughts of engineers on the topic. Furthermore, the findings of this study also expand the existing literature on the value-based design process in a sense that it identifies the moments of value trade-offs in design phases and strengthens the conceptual investigations proposed by (Friedman et al., 2013).

For managers of technological companies, the results of this research will enable them to re-evaluate their existing policies to involve the engineers during moments of value decisions and value trade-offs in design phases. Furthermore, the conclusion from the interview conducted for this research will enable the managers better to understand the significance of emotional management within their team and use it to cultivate an environment where engineers could express their emotions. Managers can use this thesis for guidance about the relationship between emotions and ethical and moral values that should tag along with the engineering. This way, they can motivate their team to use their emotional experiences to think about ethical and moral risk and which values can be involved to mitigate those risks.

1.5 Reader's Guide

The roadmap of this document is as follows:

Chapter 2 will describe existing academic literature on the topic and how it contributes to this research.

Chapter 3 will provide a rich overview of research methodology which will help the reader to understand how this research was carried out. It will describe the interview design and how the sampling process, as well as the limitations.

Chapter 4 will explain the analysis of the data obtained from the literature review as well as from the interviews conducted with software engineers. The interpretation of the data collected is explained, including the steps involved in the analysis.

Chapter 5 provides the results of the interview analysis and answers the sub-research questions realised as their sub-chapters.

Chapter 6 provides a conclusion alongside discussion and the limitations of this research. Moreover, future research recommendations will be provided in this chapter. It will assist a reader or future researchers interested in this topic to pave their research proposals for their master thesis.

A Bibliography of all the sources from which information has been acquired for this research is provided. This section will inform the reader to go through the sources and expand their scientific knowledge on, but not limited to, topics studied in this research.

Lastly, an appendix is provided, which contains information related to a few elements of this thesis which could not be included in the main content but were nevertheless, necessary for research accomplishment. Moreover, the appendix also contains codes and categories used for the analysis of

the interview. Additionally, it also contains other information that a reader might find useful to understand this research to its fullest extent.

2. Literature Review

In the previous paragraphs, I introduced the arguments presented by a few scholars about the necessity of emotional reflection for moral values during engineering design phases. What follows next is an overview of emotions, values, design phases provided in various works of literature consulted for this thesis. However, before that, I will provide the methodology by which the literature review was conducted, stating the platforms, keywords and justification for the selection of the academic work used in this thesis.

2.1 Literature Review Methodology

The search engine Google scholar searched the literature for this research and on scientific databases such as, but not limited to, Springer, Wiley Online Library, Taylor-Francis, Elsevier, Research Gate, and TU Deft Library Catalogue. Initially, many more articles were provided by supervisors which broadened the knowledge on the reflection of emotions for engineers. Moreover, the literary works also provided arguments in support for engineer having to harness those emotions for a better perception of risks and to mitigate them by involving moral values into the technology during engineering design phases. After that, google scholar was scanned for more information on values by using keywords such as "values and ethics in engineering", "emotions and values", "linking emotional values", "Human values and ethics" which generated millions of results. However, a maximum of two pages on google scholar was browsed to get a total of 10 relevant articles and a couple of e-books on google books. These articles and books had more than 100 citations. They belonged to journals and handbook such as, but not limited to "online readings in psychology and culture", "psychology and health", "social science information", "cognition and emotion" and "handbook of ethics values and technology designs" among others.

Furthermore, to understand the relationship between values and technology, keywords such as "value-sensitive design" were used on google scholar, which resulted in 5 million results. Additionally, in order to gain perspective on emotions and software engineering, keywords such as, but not limited to, "the impact of emotions on software engineers" and "software engineering and user autonomy" were entered which generated around half a million results. Among those results, four relevant articles were selected that were published in "IEEE Software", "ACM SIGSOFT", "Conference proceedings", and "Engineering Studies". In addition to that, several articles and books were explored by using the snowballing method, in which citations of available literature to find additional literature.

There were a few challenges, setbacks and limitations experienced while carrying out the literature search. Firstly, the books available on google books are redacted, meaning that a lot of pages and chapters were not available for reading. To some extent, the TU Delft library catalogue helped. Secondly, few articles and research papers which seemed useful and relevant for this research were unfortunately not available on any of the databases.

2.2 Emotions

There are various definitions of emotions in literature since the emotional processes are complex (Wolman & Pomeroy, 1973). The modern attempts to explain emotion can be traced back to 1884 when William James proposed his view on emotions. He argued that emotions are the result of physiological arousal from a certain stimulus (James, 1884). He explained that emotion could only be experienced when an individual experiences bodily responses from a certain event external to that individual (James, 1884). However, this theory was later refuted by Cannon, who argues that different stimuli can result in the same emotional states (Cannon, 1927). For instance, an increase in heart rate due to listening to strange sounds at night can result in the experience of fear. However, the increased heart can also be induced by high paced activity, such as running, which does not elicit fear. With Philip Bard, Walter Cannon proposed Cannon-Bard theory of emotions explains emotions as the response to a stimulus that occurs simultaneously with physiological changes (Cannon, 1927). Schachter and Singer proposed two-factor theory of emotions as cognitively interpreted and labelled reason behind certain physiological changes, and these changes are a response to an external stimulus (Schachter & Singer, 1962). For instance, an exam can cause physiological changes such as sweaty palms and a racing heart. The change will be cognitively labelled as anxiety. However, if the same physiological changes occur on a date, a person will experience love or affection. Another attempt to explain what emotion is has originated from the works of Lazarus, who proposed Cognitive Appraisal theory. According to Lazarus, following the stimulus or arousal, a thought-process or appraisal event occurs, which evaluates the situation and causes the individual to experience both physiological changes and emotions simultaneously (Lazarus, 1984).

Scherer proposed a component process model of emotions, in which he described emotions as a theoretical construct which consists of five components corresponding to five distinct functions [see Appendix A for

the relationship between components and sub-systems] (Scherer, 2001). In this framework, components refer to the respective states of the subsystems, and process refers to the coordinated changes between component and subsystems that occurs over time (Scherer, 2001). Through the component process model, Scherer defined emotions as "an episode of interrelated, synchronised changes in the states of five organismic subsystems of the human body in response to the evaluation of an external or internal stimulus event as relevant to major concerns of the organism" (Scherer, 2001). In sum, Scherer's theoretical framework supports and contributes to the cognitive appraisal theory of emotion. Cognitive theorists such as Scherer and Lazarus agree that physiological response and emotions are intertwined with each other after an appraisal of an event.

However, other groups of researchers argue that emotion process excludes judgement and appraisals. The non-cognitive theorists argue that the emotional response to a stimulus is devoid of any evaluation or judgement about the stimulus, akin to reflexes (IEP, 2020). In this approach, the works of Paul Ekman and Paul Griffith is notable. In Ekman's model, two interfacing mechanisms are defined, which are known as automatic appraisal mechanism and an affect programme (Ekman, 1977). He postulated that the appraisal mechanism is automatic and happens without awareness when responding to a stimulus, and the mechanism can detect certain stimuli, which Ekman termed as elicitors (Ekman, 1977). These elicitors are stimuli that are identified by the appraisal mechanism is specific for one or another emotion (Ekman, 1977). The affect programme governs and stores the patters of emotional responses from certain stimuli, such as facial response, skeletal muscle response, central and autonomic nervous system, among others (Ekman, 1977). Griffith, however, postulated a single mechanism, known as the affect program, although he also agrees that each emotion has a separate affect program (Griffiths, 1997). However, Ekman suggests that cognitive appraisals are frequently utilised, and Griffiths suggests that some emotions are mediated

cognitively, while some are constructed due to social structure (Ekman, 1977; Griffiths, 1997).

The Somatic Feedback theory of emotions is another attempt to explain the emotion process. This theory suggests that in response to a stimulus, bodily changes occur. The mind registers these bodily changes (e.g. increased heart rate, facial expression, among others) and this mental state caused by the bodily changes is the emotion. The James-Lange model of emotions contribute to the Somatic Feedback theory, and researchers such as Antonio Damasio and Jesse Prinz have contributed and expanded the somatic feedback theory (Damasio, 1994; Prinz, 2004). The term somatic refers to the brain and body-related signals which is experienced as a form of emotions and feelings (Denburg & Hedgcock, 2015). Damasio defines emotions as changes in both body and brain states in response to a stimulus (a particular situation). He referred to the bodily changes as "somatic markers", and along with the emotions, they get associated with that stimulus that caused the bodily changes in the first place. Damasio presented the somatic-marker hypothesis, which states that when faced with uncertain situations, the cognitive aspect can get overloaded, and thus emotions and feelings serve an essential guide to make decisions (Damasio, 1994). Jesse Prinz is another emotion theorist who argued that in emotions do not simply occur as acts of cognition since "we do not choose to be afraid" (Prinz, 2004). According to Prinz, even though a change in bodily states causes emotions, they do not represent changes in bodily states (Prinz, 2004). He presented a perceptual theory of emotions that argued that emotions are the perception of bodily changes and not a direct response to a stimulus (Prinz, 2004). For example, the mind perceives whether a stimulus is dangerous or not. If the brain perceives a situation as dangerous, then this perception causes a combination of several bodily changes (increase in heart rate, sweaty palms, among others). Prinz argued that these bodily changes are registered by a "bodily perception". Thus, bodily perception is caused directly by bodily changes but indirectly caused by "danger". In essence, Prinz's perception theory is the hybrid of

cognitive and somatic theories of emotions, arguing that emotions are central to bodily changes but it emphasises the meaningfulness of emotions, which is recognized by cognitive theories.

Frijda et al. defined emotions as "a result of how an individual believes the world to be, how events are believed to have come about, and what implications events are believed to have" (Frijda et al., 2000). Frijda and colleagues support the opinion that emotions influence the beliefs of people. They argue that emotions can play a role in awakening and shaping beliefs and making them resistant to change (Frijda et al., 2000). The authors believe that emotions hold a temporary appraisal for an event which in turn creates long-lasting beliefs. They propose that emotions can shape beliefs by creating, amplifying and making them resistant to change (Frijda et al., 2000). This is why beliefs which are formed by emotions are extremely difficult to change.

Thus, it can be observed that several groups of researchers theorise emotions differently, which renders a consensus on emotions complicated. Additionally, researchers have also categorised emotions based on their influence on people's behaviour and their ability to make decisions such as epistemic, incidental, transient and moral emotions, among others (Andrade & Ariely, 2009; Greenbaum et al., 2020; Morton, 2010; Pekrun, 2006; Pekrun et al., 2002; Roeser, 2018). Among these emotions, moral emotions shall be the focus of this research from hereon.

2.3 Moral Emotions

Haidt defined moral emotions as emotions that "are linked to the interests or welfare either of society as a whole or at least of persons other than the judge or agent" (Haidt, 2003). In other words, moral emotions are those which arise during the events that are perceived to have a moral component or motivate an agent towards actions that carry a moral component (Kroll & Egan, 2004). According to Kroll & Egan, guilt, shame, remorse, and regret are a few examples of moral emotions, albeit those emotions may have non-moral aspects as well (Kroll & Egan, 2004). Haidt has grouped moral emotions into four families based on whether the focus is on the person whose behaviour violates the moral standards, or the victim who suffers because of such violation (Haidt, 2003). These are other-praising emotions (gratitude and elevation), other-suffering emotions (sympathy), other-condemning emotions (contempt, anger, disgust) and self-conscious emotions (shame and guilt) (Haidt, 2003).

The role of emotions in moral life has been a topic of debate in the field of moral philosophy. Early philosophers such as Ralph Cudworth, Samuel Clarke and Immanuel Kant have postulated that moral decisions should be taken by reason alone and that any moral action should be based on reason and duty. For Kant, emotions and feelings can help moral agents to recognize their moral duties (Dąbrowski, 2016; Sherman, 2014).

On the other hand, philosophers such as Francis Hutcheson and David Hume have rejected moral rationalism and argue that moral decision-making should have an emotional or sentimental element to them (Hume, 2003). It can be observed that there is a dichotomy between reason and emotion, and many meta-ethicists presuppose that emotions and rationality are distinct sources of insight. This has given rise to sentimentalist view and rationalistic view on emotions. Rationalists argue that emotions are subjective and irrational. In their view, moral standards are absolute and universal while sentimentalists argue that reason is

insufficient for moral judgements and sentiments should be involved along with a reason to gain an accurate perception of moral judgements (Gill, 2007).

In rationalistic view, empirical decision theories in moral psychology have gained popularity among scholars such as Joshua Greene and others, who have postulated Dual Process Theory (Greene, 2001). It states that moral judgements are determined by two different systems of an information processing system within people to make judgements. The first system is intuitive and provides people with fast heuristics and is supposed to be driven by emotions and intuitions, while the other system is more analytical, rational and conscious, although needing more time and resources to make judgements (Greene, 2001; Kahneman, 2011). Moral psychologists have endorsed a similar view. According to Haidt, emotions are moral judgements, and people use them often to make judgements on what is morally correct (Haidt, 2001). However, Haidt still considers emotions to be irrational and states that our moral judgements are formed by spontaneous and intuitive gut reactions, while rationality justifies those judgements post-hoc (Haidt, 2001). Roeser argues that this approach completely discards emotions as irrational and subjective states (Roeser, 2012). She argues that moral emotions do not fit into the dual-process theory because they are reflective, justifiable and based on reasons (Roeser, 2009). Thus moral emotions are essential to have well-grounded insights about situations (or state-of-affairs, objects) are morally acceptable or not.

Scholars such as Nussbaum, Bagnoli and Rorty argue that emotions play an important epistemic role (Bagnoli, 2011; Nussbaum, 2001; Rorty, 1998). On this account, Roeser argues that moral emotions should play a vital role in debates concerning risks (Roeser, 2018). Fear, enthusiasm, sympathy and empathy are essential emotions for the assessment of moral values of risks and benefits associated with technological development (Roeser, 2006). It is also morally reasonable to express discontent and feel outraged if an individual has

to experience technological risk while not receiving the appropriate benefit (Roeser, 2006). People will express negative emotions to a technology whose harm could be disastrous with low probability, compared to a technology whose harm is low with high probability (Roeser, 2006).

Furthermore, to gain moral knowledge, it is necessary to be able to perceive how it feels to experience a particular situation or whether someone is hurt or happy. Without the ability to feel sympathy, empathy or compassion towards others, it is really difficult to understand the significance of morality and therefore make sound moral judgements. Moral emotions can provide a better understanding of how people would be affected by the technological risk product and facilitate ways in which one could mitigate them.

Additionally, the acceptability of moral risks depends upon the considerations whether risks were taken voluntarily, distribution of risks and benefits, alternative technological products and that higher probability of a small risk being more acceptable than the lower probability of high risk (Roeser, 2006). In all the above considerations, emotions play a significant role. For instance, the risk imposed on people without their voluntariness might lead to people experiencing negative emotions such as anger and frustrations, which is a justified reaction. It means that people with the capacity to experience moral emotions would have a rational reaction when their values are negatively affected by a technological product. Furthermore, the unfair distribution of risk and benefits of a technological product would also influence the emotions of people using it. If people see that they are exposed to more risks than the benefits of a technological product, it is morally reasonable for people to express negative emotions towards it. However, without having the ability to feel such emotions, an individual might be unable to assess a possible unfair distribution of risk or whether they are involuntarily imposed with technological risks.

Therefore, in order to obtain a full insight of morally acceptable risks, the role of emotions is significant. Despite being fallible at times, moral emotions are important to make a well-grounded moral reflection on the risks and benefits of the technological product. A question arises whether moral reflections can be accomplished during engineering design phases to evaluate risks and whether emotions can be used as a source to assess which risks are morally acceptable to all the stakeholders involved during the development of the product.

Elsewhere in this thesis, I have mentioned that risks and value-sensitive design are the two sides of the same coin, meaning that accounting for moral values in technological development will help mitigate the risks associated with the technology. Scholars who are the proponents of involving values in design phases of technology support rationality and reasoning to form well-grounded insights and do not consider emotions as a source of reflection on values. However, Roeser argues that the involvement of values in design can diminish risks during the designing phase itself (Roeser, 2012). Thus, not only should moral emotions play an important role in well-grounded risk assessment, but they can also be an essential source for reflecting upon the moral values, through which those risks can be mitigated. The above argument does not undermine the role of scientific methods that deal with decisions concerning values but proposes that emotions and scientific methods should be balanced to form significant insights for moral values.

The quantifiable notions do not account for values such as justice, autonomy, human welfare among others, which are critical ethical considerations and should be reflected in moral judgements of risks associated with the technology (Roeser, 2018). Moral reflection is essential to provide a complete overview of the risk, and this reflection should also be performed during the engineering design phases by engineers (Roeser, 2012).

It is, therefore, becomes essential to understand what values are and what role they play within the arena of technological development and is explained in the following sub-section.

2.4 Values

Values are "lasting convictions or matters that people feel should be strived for in general and not just for themselves to be able to lead a good life or to realise a just society" (van de Poel & Royakkers, 2011).

The philosophical investigation in value theory deals with understanding the concept of the “good”. Philosophers have made many distinctions in the treatment of value. Values can be intrinsic or instrumental (van de Poel, 2009). According to Zimmerman, the intrinsic value of something that that thing has “in itself,” or “for its own sake,” or “as such,” or “in its own right” (Zimmerman, 2002). Zimmerman argues that intrinsic values are crucial to moral judgements (Zimmerman, 2002). For instance, in consequentialism, a morally right or wrong action depends upon whether its consequences are intrinsically better than other action performed under similar circumstances (Zimmerman, 2002). In terms of intrinsic values, the works of G. E. Moore and Christine Korsgaard is notable. Moore believed that values (he referred to values as goodness), is an unanalysable property, meaning that it cannot be analysed in terms of natural or descriptive properties and thus, an object (including state-of-affairs or persons) can bear intrinsic values (Moore, 1922). Moore also argued that the notion of intrinsic values combines two aspects: the value that only depends on intrinsic properties of the object and final value, meaning value for its own sake (Moore, 1922).

Following this, Korsgaard argued that objects that are valuable due to their intrinsic properties are unconditionally good (Korsgaard, 1983). Both Moore and Korsgaard agreed that the goodness of objects that bear intrinsic values do not depend on their relation with the values of other objects. Korsgaard also argued that things such as human happiness might be good for their own sake even though they are not unconditionally good; that is, happiness is a final value (Korsgaard, 1983).

Values can also be of different types such as epistemic value, aesthetic value, pragmatic value, economic value, utility value and moral value (van de Poel, 2009; Van de Poel & Kroes, 2014). Van de Poel argues that a technological product or service might have a utility value because a technology can be used for some end means, an instrumental value because the technology can be used to achieve a means, negative (referred to as disvalue by van de Poel) or positive (van de Poel, 2009). Engineers design a technological product or service with certain intentions in mind, i.e. a plan in which the product or service should be used to achieve certain user ends (Houkes et al., 2004). Hence, instrumental values are conceptually inherent to the technological product or service.

Of course, the intended instrumental value of the technological product or service may differ from the actual instrumental value due to the way it is used (van de Poel, 2009). Technological products or services are not always used as they were intended but can also produce harmful side-effects. For instance, the internet has been valuable in gaining and sharing knowledge, increasing connectivity between people, and raising awareness for a number of social problems, but it has also been used against the well-being of society. The negative effects of social media on young adults have been very well documented in research and media. Because of these undesirable outcomes, technologies have risky implications for the well-being of society (Roeser, 2018). Some of the common moral values in the technological domain are provided in table 1. Philosophers and social scientists have asserted that technological products or services should be intrinsically value-laden, and moral values should be accounted for during the design process itself thus giving rise of value-sensitive design (Friedman, 1996; van de Poel, 2009).

As mentioned earlier, when the design of technologies account for moral values, it is known as the value-sensitive design, which is a theoretically grounded approach (Friedman, 1996; Friedman et al., 2002, 2013, 2017; Friedman & Borning, 2002). It is grounded in the belief that the technology

we use strongly influences our lived experiences as well as our ability to meet our goals (Davis & Nathan, 2015). In technological contexts, accounting for values can be particularly challenging in the sense that they can interfere with the economic goals of the product and are also challenging to translate into the exact process of designs (Friedman, 1996). Value sensitive design can be applied to any branch of engineering but is more prominently found in computer science and engineering. Friedman and colleagues have listed several values that are often associated with the design, and these are listed in the following table.

Table 1 Values implicated in system design (Friedman et al., 2013)

No.	Values	Working definition
1.	Human welfare	People's physical, material and psychological well-being.
2.	Ownership & Property	Right to possess and object, use it, manage it, derive income from it and leave it for someone else.
3.	Privacy	An individual's claim, entitlement and a right to what information about himself or herself can be communicated to others.
4.	Freedom from bias	Systematic unfairness on individuals/groups, that includes social bias, technical bias, etc.
5.	Universal usability	Making all people successful users of technology.
6.	Trust	Expectations existing between individuals who can experience and extend good, experience vulnerability and betrayal.
7.	Autonomy	People's right to decide, plan and act in ways that might help them to achieve their goals.
8.	Informed consent	Collecting agreement of people where the agreement circumscribes disclosure and comprehension criteria, as well as agreement on voluntariness and competence.
9.	Accountability	Properties that make sure actions of individuals, groups, institution can be traced.
	Courtesy	Treating people with politeness and consideration.

10.	Identity	People's understanding of who they are over time.
11.	Calmness	Peaceful and psychological state of mind.
12.	Environmental sustainability	Sustaining ecosystem and ensuring the resources meet the present and future generations.

The proponents of value-sensitive design claim that these values can improve the design of products or services (Davis & Nathan, 2015). In turn, the improved design can significantly reduce the risk implications of those products and services, as mentioned earlier (Roeser, 2012).

Van den Hoven questions the attempt to express values on the same scale as money or utility (van den Hoven, 2015). For instance, the monetary value of a piece of nature scores higher when people are questioned how much would they want to be compensated for giving it up, instead of questioning them how much are they willing to pay (Horowitz & McConnell, 2000). There are also additional methodological and ethical issues in cost-benefit analysis such as bias, prediction problems, excluding certain consequences due to moralism and incommensurability of consequences (Hansson, 2007). Roeser also questions whether cost-benefit analysis is sufficient to judge whether a risk is morally acceptable or not and argues that risk is not simply a quantitative notion, but also involves values (Roeser, 2018).

Not every value can be involved in the development of a particular technology. Often, decisions would be made about prioritising certain values over others due to technical feasibility and financial aspects during the development of technology, giving rise to confliction of values and trade-offs. The next subsection provides a rich overview of what value-conflicts are how do they influence trade-offs among values in technological design.

2.5 Value Conflicts and trade-offs

A value conflict can be defined as "a situation where:

1. A choice needs to be made between at least two options for which at least two values are relevant as choice criteria.
2. At least two different values select at least two different options as best, and
3. There is not one value that trumps all others as the choice criterion" (van de Poel & Royakkers, 2011).

To design a product using a value-laden or value-sensitive approach, values such as safety, sustainability, privacy, autonomy, justice, among others, are often promoted (Davis & Nathan, 2015). It is likely that when multiple values are accounted for, one value is given more preference than others, leading to conflict in values, which becomes a persistent engineering problem and needs to be resolved. Confliction between values can be problematic also because engineering will not be able to account for all the values in his or her engineering design (van de Poel & Royakkers, 2011).

Trade-offs occur when having one desirable value, requires giving up another desired value (Gregory, 2002). Trade-offs are another approach to deal with the conflict between values where one can make direct trade-offs between values. Moreover, value trade-offs are decision-making phenomena with multiple-objective decisions and calls for the need to make well-grounded insights (Keeney, 2002). Trade-offs require unit commensurability, meaning that those values should be expressed on a standard scale, and this scale should be interval or ratio scale (van de Poel & Royakkers, 2011; van den Hoven, 2015). Since it makes sure that values are commensurable, it avoids the need for expressing values in terms of money.

There are often pitfalls to value trade-offs. Keeney identified several pitfalls in value trade-offs that should be avoided (Appendix B). With so many pitfalls to make value trade-off, it is evident that value trade-offs should be made with a careful approach, such as (Keeney, 2002):

1. Framing the decision appropriately,
2. Structuring the value trade-off problem,
3. Determining indifferent pairs of consequences,
4. Assuring reasonableness by revising value trade-offs as appropriate.

As I mentioned earlier, value trade-off is one of the approaches to resolve value conflicts. When looking through the lens of engineering design, I argue that the conceptual investigation in the Value Sensitive Design methodology mentioned earlier should be considered analogous to value trade-off method, since it investigates the trade-offs between competing values in technology. Value trade-offs in engineering certainly deal with investigating which value should be associated with the product design, such as autonomy vs security. Avoiding the pitfalls mentioned by Keeney through appropriate improvement steps should enable the stakeholders involved in engineering design to incorporate appropriate values in the product.

Engineering design is defined as "the idealised approach, which engineers are trained to recognise and informs their practice" (Foley & Gibbs, 2019). Engineering design is also defined as "the process by which certain functions are translated into a blueprint for an artefact, system or a service that can fulfil these said functions" (van den Hoven, 2015). Even though engineering is a cyclic and iterative process, there are several design phases within its realm. The design process starts with (van de Poel, 2009):

- A problem formulation and definition phase, where formulation of design requirements happen as well as planning the design and development of the product is conducted.

- Conceptual design and specifications, including a possible reformulation of the problem.
- Selection of one conceptual solution.
- Embodiment design where the material/structural solution is worked out.
- Detail design which functions as a blueprint for the production process.

The design phases mentioned in the above steps are not rigid but vary as per emphasis and technological need, but they universally adhere to core principles, including codification of requirements and constraints. On these steps, explicit decision-making happens in separate divergent and convergent thinking phases (Foley & Gibbs, 2019).

Value trade-offs are an inherent part of decision-making in engineering design phases. The moments of decision-making concerning value trade-offs are most prominent and explicit during the design requirements phase and during the phase where a design solution is selected after catering for the trade-offs (van de Poel, 2009). For example, in the first phase, i.e. formulation of design requirements, values influence how a problem is conceived and framed. Earlier in this thesis, I have provided arguments supporting the helpfulness of moral emotions in the assessment of values involved in the technology. Given the argument above that decision-making concerning value trade-offs are essential to assess which values should be involved in the development of technology, it can be argued that moral emotions could influence these moments. In other words, moral emotions, along with traditional methods, can play a role in influencing value trade-offs.

Since the moments of decisions concerning value trade-offs occur during the engineering design phase, engineers should be able to experience them. The question arises whether the engineers, as rational and quantitative as their mindset is towards values, experience moral emotions and use them

to reflect on the values and are involved in the decisions during the moments.

2.6 Software Engineers and Ethics

The focus of this thesis is to research on the moral emotions of engineers who are working in the software industry. This industry has witnessed some enormous growth in both developed and developing nations. According to a report, software and associated information technology industry is set to reach $5.2 trillion by the end of 2020 (CompTIA, 2019). Almost all industries, e.g. education, communication, healthcare, financial automotive, consumer, media, logistics, among others, have begun to embrace digital transformation (Accenture, 2016). The social and economic impact of the technology industry can be observed on a global scale as businesses continue to adopt emerging technologies such as artificial intelligence, machine learning and Internet-of-Things to innovate their products and services (Sykes, 2018).

With such a tremendous impact on a global level, the technology industry has come under the scanner of ethicists concerning the negative effects of industry on society. Security, privacy, justice, autonomy are some of the moral values that are considered at risk by experts (CompTIA, 2019). The rise of depression, social anxiety, suicide attempts in young adults have been linked with the rise of social media (Twenge, 2020). Similarly, the risk of privacy of patients in healthcare, data theft in the financial sector, and increased risk of accidents due to rise in the level of automation in the automotive sector are some of the examples of risk debates among ethicists (Layman, 2008; Anderson & Agarwal, 2011; Ryan, 2020). These debates often end up in stalemates due to lack of a responsible stakeholder who can be accounted for these risks.

Roeser has argued that engineers are at the forefront of technological development and are involved in engineering design processes more than any other stakeholder (Roeser, 2012). As mentioned earlier, Roeser and

colleagues have argued that moral emotions can play an important role in the reflection of values of the technology during the engineering design process (Desmet & Roeser, 2014). Engineers play a central role in building a technical product and they are present in almost all stages of the engineering design process, and thus, it makes more sense to allow engineers to conduct a moral assessment of risks, which, as argued before, should be done by involving their moral emotions (Roeser, 2012). Engineers, therefore, should use their technical expertise as well as moral emotions to perform effective moral judgements on the moral values of the technology during the design phases. The moral emotions would enable the engineers to get sensitive towards moral issues that may arise from their technologies. Having such emotions can also benefit the engineers to develop value-sensitive technologies that pose the least amount of risks to the users and society. The moral responsibility of engineers in the design process should include moral emotions like shame, guilt, resentment, blame, sympathy, empathy and compassion.

Hence, it is proposed that software engineers should combine their reasons and emotions to reflect upon the trade-offs concerning moral values associated with the development of technological products or services such that their negative impacts can be mitigated.

2.7 Conclusion and Key Takeaways

Earlier in 2.2, I argued for the support of moral emotions in a moral reflection of the risk. In addition to moral reflectivity, I have also overviewed value trade-offs that are of ethical importance arise and should be resolved. The necessity for conflict resolution entails that technology is pervasive, meaning that humanity has been deeply influenced by technology as I have already mentioned earlier. Furthermore, technology is integrated through the very fabric of our society and invokes positive and negative emotions on interaction with it. (Desmet & Roeser, 2014). These emotional responses represent an individual's personal and moral values as well as disvalues that can be intended, unintended or utterly unforeseen by the designers of the technology (Desmet & Roeser, 2014). Moral emotions are needed to form well-grounded insights for the moral values involved in the technologies (Desmet & Roeser, 2014).

Therefore, based on the academic literature from Haidt, Krol & Egan as well as Roeser, the following moral emotions have been selected to design this research: guilt, shame, regret, remorse, anger and sympathy.

Most certainly, logical reasoning and sound rationality are irreplaceable for moral judgement of risks or inclusion of values and emotions should never create an obstacle to value decision making (which includes value trade-offs). Both emotions and rationality are significant for important value considerations. Emotions of different stakeholders such as users or engineers should be taken into account to inspect ethical aspects of the technology since they might be the valuable sources of moral knowledge (Desmet & Roeser, 2014). Analysing the consequences of the technology during the engineering design phases by developers can result in morally acceptable technology, and thus engineers should take moral responsibility and emotional sensitivity to achieve this. One of the ways to achieve this is that developers and engineers sympathise with the potential victims of the technology which should make them feel more involved and

responsible during the moments of value trade-offs (Desmet & Roeser, 2014). The list of moral values provided by Friedman in table 1 is selected for this research.

Furthermore, it was found that there are four phases in the engineering design process and that moment of value decisions rises during the first and third design phase. Therefore, this research culminates the entire theoretical arguments into an exploratory study design to investigate to what extent engineers reflect upon their emotions as a gateway to involving moral values during the engineering phases. I am curious to explore how software engineers perceive their emotions to form well-grounded insights for decisions when they experience moments of value trade-offs.

3. Research Methodology

3.1 Interview Design

The research interviews are a conversation between a researcher and human participant where the researcher asks clear, concise and unambiguous questions without any vagueness are answered by the participants as they seem fit (Saunders et al., 2015a). For qualitative studies such as this research, interviews are popular areas of interest which provide in-depth information relating to the experiences and viewpoints of individuals (Turner III, 2010). The interviews can be designed to attain formalised structure using standardised questions for interview participants or can be designed to have informal structure, depending on the purpose and objective of the research. More often than not, interviews take intermediary position in the sense that some parts of the interview will be structured and formalised, while other parts can be open-ended and informal (Saunders et al., 2015b). The topics of this research require that the participants reflect their thought process and think deeply within themselves to provide answers, thus making the interaction quite personal. Three major types of interviews are present in the literature: structured, unstructured and semi-structured interviews, out which semi-structured was selected for this study.

Semi-structured interviews: Similar to unstructured interviews, these types of interviews are also conducted for qualitative studies (Saunders et al., 2015a). The researcher has a clear theme and list of questions scheduled to be asked to participants, however, depending on the flow of conversation the order of the questions could be re-iterated (Saunders et al., 2015a). Furthermore, this approach to an interview is beneficial for small-scale research and allows several degrees of freedom for the participants to express their views (Drever, 2003). Semi-structured interviews contain few key questions to be covered with the scope of

variation is present from interview to interview, meaning that few questions can be omitted depending upon the organisational context encountered about the topic of interests in the research. Moreover, the nature of conversations and discussion requires the audio-recording of the interview at the very least (Saunders et al., 2015b). An additional feature of the semi-structured interviews is that there could be a possible list of prompts provided by the researcher to the participants to promote further discussions and to generate answers from the participants. These "prompts" were frequently used in interviews conducted for this research to allow software engineers to think about the topic of interests of this study. Since, the nature of this research is exploratory by design, selecting semi-structured interviews was prioritised among other forms of interview structure, which is well argued by Saunders et al. which was one of the primary sources of information used to design the data collection methods for this research. The researcher needed the participants to explain and build upon their responses with the use of *nudges* and these *nudges* facilitated the participants to deeply reflect upon the topics of research, which added depth to the obtained data.

After deciding upon the category of interview suitable for this research, the next sub-section provides information on population and sampling design for this research.

3.1.1 Population and Sampling Design

Population refers to the "entire group of people, events or things of interest that the researcher wishes to investigate" (Sekaran & Bougie, 2016). As per the research objectives and questions of this study, software engineers were the population for this research. However, owing to the restrictions with time and access, a suitable subset of the population was chosen. The process of selecting some members of the population for research is known as sampling (Sekaran & Bougie, 2016). Since, the characteristics of this research are qualitative involving values, ethics and emotions, non-probability sampling was selected.

Non-probability sampling is the one where each member of the population, known as **elements** do not have any probabilities of being selected as sample **subjects**. The non-generalisable characteristic of this study is the prime motivation for deciding upon non-probability sampling since qualitative studies tend to explore complex human behaviours, and have values, beliefs and attitudes at the core of the study. Thus, it is difficult to find a suitable random of non-probability samplings, such as convenience sampling and purposive sampling (Marshall, 1996; Saunders et al., 2015b; Sekaran & Bougie, 2016).

3.1.2 Interview Procedure

In order to collect data through semi-structured interviews, subjects were contacted through several digital platforms. Among them, LinkedIn was selected as the platform to contact software engineers, as it is a professional social media website. Employees with two to five year of work experience were considered. The participants were searched by using the keywords "software engineers" and then selecting "people" as a search filter on LinkedIn. After that, the researcher carefully screened each profile to select participants based on the criteria such as work experience and companies. The first message of the invitation was as follows:

Hi [name], I am a masters student studying at TU Delft, and for my master thesis I am looking for software engineers who would be interested in participating in a short interview with me covering the topics on emotions, values and ethics. Kindly let me know if you are interested.

As many as 50 distinct invitations were sent through LinkedIn. Among those 50 invitations, 15 responses were positive and showed interest by stating the following:

Hey Sawan, I am interested, let me know the details.

To those 15 respondents who replied positively, the researcher then provided a summary of the project as well as the administrative details as follows.

Emotions play an essential role in bringing out values in people, and values generate meaning to an individual's life. However, values are not limited to people but they can also be involved in technology, which we ethicist believe is the need of the hour, given that world is getting increasingly connected digital and so it might have unintended risks for society as a whole. On the other side, engineers play a pivotal role in the development of any technology, and we believe that instead of engineers trained to become rational, calculating beings, engineers should use their emotions to bring out moral and ethical values into the technology, rather than it being the duty of just policymakers and other stakeholders. Using this premise, I am investigating to what extent are engineers able to influence values and morals into technologies using their emotions.

Due to unprecedented COVID-19 situation, conducting an interview using the face-to-face method became impossible, and thus, the VoIP platform to conduct interviews was selected. Keeping this in mind, the administrative details were provided immediately after the summary mentioned above to the respondents as following.

The interview takes a maximum of 40 minutes. What I do usually is that I have set up a Calendly link and provide it to you where you can choose the day and hour slots as per your convenience. With Calendly, a zoom link is also attached where we will have our discussion. Once you have booked the time and slot, I will also give you an informed consent form which you can sign digitally or by hand and also know how your data will be processed, stored and eventually be discarded after the completion of the thesis. Let me know if you have more questions as well as whether I can send you the Calendly link now. :) Cheers!

A scheduling link was sent to them in the next message. When the participants selected the time and day, a confirmation email was sent to the researcher, and the "event" was saved in Google Calendar. Furthermore, an informed consent form, approved by the Human Research Ethics Committee, TU Delft, was sent to the participants asserting their privacy with respect to their name, age, gender, and the company that they work for, during the interview. The respondents were asked to kindly read and subsequently sign the form and revert the form to the researcher. Moreover, the participants were notified of audio recordings and making notes for analysis and transcribing purposes.

In total, a total of 9 from the 15 participants appeared for the interview. Furthermore, the researcher is aware of the small sample size, and it is reflected in the limitations chapter of this document.

In order to prepare for the interview, the appropriate literature was consulted. According to McNamara (2009), there are eight principles for

the preparation stage of the interview. These principles are listed below (McNamara, 2009):

1. Choose a setting with little distraction: This meant avoiding loud lights or noises and ensuring that the interview participant was comfortable. The researcher conducted interviews in a dedicated silent room while informing the other residents not to disturb while the interview was in process. Furthermore, attempts were made to establish rapport with the interview using *small talks* before the interview.
2. Explaining the purpose of the interview: Even though it was expected that the participants must have read the summary on LinkedIn message, the researcher explained the purpose, objective and research questions to each participant and further inquired if they had any question, before asking the first question.
3. Address the terms of confidentiality: The administrative details were also conveyed providing them information about the informed consent form, the recording of the interview session for generating the transcripts, and asserting their anonymity concerning their name, gender, age or company that they work for.
4. Explain the format of the interview: The sample subjects were informed about the semi-structured nature of the interview and that they should think and reflect deeply within themselves to provide information about the experiences concerning the topics of research. Additionally, requests were made to the subject samples to inform the research in case there is unclarity with any questions.

5. How long the interview usually takes: During the textual conversation with the potential sample subjects as well as at the beginning of the interview, it was informed that the interview should take around 40 minutes. Based on the length of the responses and freedom of flexibility with questions, some interviews lasted less than 40 minutes, while few were stretched to 60 minutes.
6. How will they get in touch with the researcher if they want to: It was informed to the sample subjects that they contact the researcher using LinkedIn or email address, which were provided to them during the initial approach of sending invitations to potential participants.
7. Asking whether they have any questions before the start of the interview: As explained earlier, this action was performed after the explanation of the administrative details.
8. Not counting on memory to recall the answers: This was avoided by recording the interview using the in-built feature of the Zoom and Skype platforms. The recordings were later transcribed for analysis.

3.1.3 Possible Biases

Although care was taken while designing the interview protocol in order to mitigate biases, it is implausible to think that any research will be completely free of it. The aspects relating to appearance, opening statements, approach to questioning, behavioural impact are all known to play a role in inducing biases in the respondents (Saunders et al., 2015a; Sekaran & Bougie, 2016). Interviewer bias, interviewee or response bias, participation bias and biases originating due to cultural differences are some of the biases that can seep into the interview research (Saunders et al., 2015b). Interviewer bias is where the comments, speaking style or non-

verbal behaviour of the interviewer affects how the interviewees respond to the questions. Interviewer bias may have affected the answers provided by a respondent at some point. Furthermore, culture bias could have affected the responses as well since 8 out of 9 participants belonged to India. Furthermore, two participants who were contacted through email live in India and thus some element of the culture might have affected the responses.

3.2 Interview Questions

A total of 13 questions were formulated to answer the first part of the leading research question. Among those, one pair of questions were alternative to each other. Questions 1-3 were open questions directed towards understanding the interviewees and establishing a rapport. The purpose of question 4 is to understand the series of design phases practised at the organisation of each interviewee. Another purpose that the question served is to identify the potential moments where the engineers should have experienced moments of value conflicts and trade-offs. The third purpose of the question was to set the path for questions dealing with satisfying the research objectives of this thesis. The interviewees were observed to express puzzlement on question 5. Counter-questions such as "what do you mean by values" and "I am not sure if I am answering you correctly but…" were heard despite making them aware of the concepts.

Nonetheless, I provided them with examples of moral values and their importance in technology which gave them a better understanding of the question. Questions 6 to 11 were directed towards exploring the extent of the emotional experience of the interviewees in the context of moments of decisions on value conflicts and value trade-offs. Questions 12 and 13 were directed towards the opinions of engineers on the extent of emotional influence required to influence the association of moral values in the engineering design phases.

Table 2 Interview Questions

Number	Questions	Reasoning
1.	Please introduce yourself stating your name and your role in the company you work for.	A brief introductive response. The answer to this will be kept confidential as per the agreement.
2.	Is there any project you are working on/what the most recent project you worked on in your profession was?	This question motivated the sample subjects to explain about their project while also shedding light whether the subjects were present from the beginning or whether it was an ongoing process when they joined.
3.	Who introduced the project to you and your team?	To gather responses to the hierarchy of the organisation. This helped to discuss how a project is trickled down to the engineering team.
4.	Please explain the series of steps that are followed after the project is introduced?	To gain information about the series of engineering design phases that is followed in the respective companies of the organisations.
5.	Have you or your team discussed the concept of values during the project? If yes, at which stage of the project was it discussed?	To motivate the subjects to reflect upon ethical/moral values that the team may have or may not have discussed in their projects.
6.	Were you, as an engineer, involved to decide which values are going to be included, please explain what happened during the moments of value decisions? How did you feel during those decisions?	To gain collect data whether the value decisions were made at the managerial level or whether engineers were involved. Furthermore, this question also generated the emotions of the participants.
7.	Since you were not part of value decisions, how did you feel about the decided values of the project?	To generate responses on emotions regarding the values of the project when they were decided by senior level.

8.	How did these emotions influence your work in the project?	To generate responses to the effect of the emotions in their work.
9.	Were you able to display the same emotions that you experienced during the moments of value decisions?	To generate responses in order to create an understanding of the emotional management of the respondents.
10.	Have you experienced value trade-offs? If yes, how did you feel about them in terms of your emotions in those moments when value trade-offs were being discussed?	To generate data on emotional responses on value trade-offs, provided that it happened during design phases.
11.	Did you experience your values conflicted with values that went into on the project? **How did you feel during those conflicts, and why?**	To generate responses on the confliction of personal moral values of the respondents with the values of the project.
12.	In what way do you think that your emotions can guide you towards designing for values?	To generate opinions of the respondents on the role of emotions in influencing the design to be more value-sensitive.
13.	Can you think of any other ways that engineers can influence those practices?	To generate opinions of respondents if they disagree that emotions can influence the value-based development of technology.

3.3.Interview Data Analysis

Interviews result in an immense number of data, and in order to interpret the data, it is necessary to reduce the data into meaningful conclusions. The process of reducing the interviews to meaningful data is carried out in three steps as indicated by Sekaran & Bougie, (2016).

1.3.1 Data Reduction

The reduction of interview data is carried out through appropriate coding and categorization. Sekaran & Bougie define coding as "Analytic process through which the qualitative data are reduced, re-arranged and integrated to form theory (Sekaran & Bougie, 2016). Moreover, codes are labels attached with the unit of texts (words, phrases or sentences), and they are later grouped to form a category (Sekaran & Bougie, 2016). Categorization involves the process of organizing, arranging and classifying coding units (Sekaran & Bougie, 2016).

The interview data was uploaded to qualitative analysis software, which facilitated the formation of codes and categories. Each interview was read line-by-line simultaneously assigning codes to words, phrases or sentences (also known as units of texts) which were considered important from the research objective point-of-view. For instance, a unit of texts from the answers of the interviewee which were observed to be interesting, repeating, or remarkable were assigned with appropriate codes. On certain occasions, these units were themselves assigned as codes. An example is provided in the following figure.

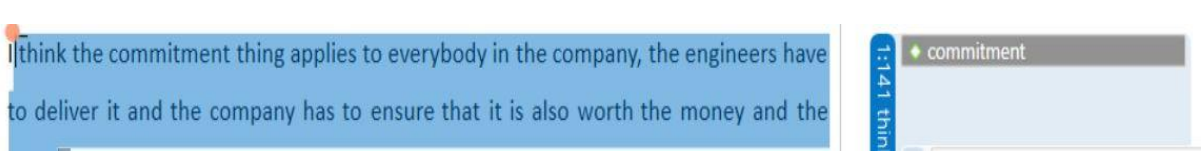

Figure 1 Sample of code from interview transcript

The next phase in data reduction involved categorization of the codes, also known as axial coding. The sub-research questions were used to form

categories. For example, the first category to be formed was termed emotions since the first sub-research questions ask "Which emotions are experienced by the engineers and in which context?" In this category, any emotion expressed by the interviewees were merged, resulting in 16 distinct emotions. Similarly, codes associated with moments of value trade-offs, perception of engineers on the significance of moral values and emotions were combined into their respective categories. An example of such a category is provided in the figure below.

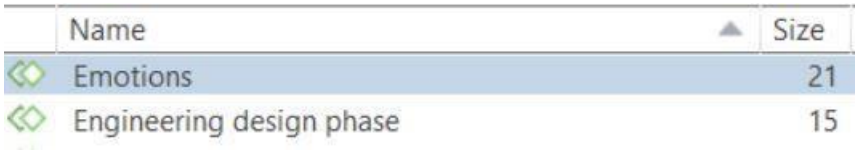

Figure 2 Sample Category of Codes

In total, around seven categories were found significant to satisfy the research objective as well as to answer the research questions. The entire list of categories can also be viewed in appendix C.

1.3.2 Data Display

The other significant activity performed for interview data analysis is the data display. It involves displaying the reduced data into an organised and condensed manner which facilitates ease of understanding (Sekaran & Bougie, 2016). In this research, the reduced data is displayed through several figures and tables. However, figure and tables did not display the motivations and insight of the interviewee, and therefore, interviewee quotations are also attached to the data display method.

1.3.3 Drawing Verification and Conclusions

Drawing conclusions is quite a challenging task for qualitative data. The conclusions of the interview analysis should be meaningful enough to satisfy the research objectives as well as answer the research questions. Coding and categorizing the interview helps in reducing the amount of data

that need to be analysed and provides a helicopter view of the data. Based on the above activities, the next chapter presents the results in detail by answering each sub-question and answering the main research question at the end.

2. Results

This chapter presents the results and interpretation of the interviews conducted with the engineers who are currently working in the software engineering companies. As mentioned in the previous chapter, the interview transcripts were coded and categorized by the qualitative data analysis software. The codes and categories can be found in the Appendix.

4.1 Values and Moments of Value Decisions

According to Friedman and colleagues, the value-sensitive design is an approach to design technology in such a way that it accounts of values (Friedman et al., 2002). From the answers to questions concerning values, 25 values were found and coded in the first phase of analysis. Subsequently, these codes were reduced during the axial coding phase. The values identified in the analysis were privacy, correctness, productivity, data protection, human welfare, informed consent, transparency and ownership. These values are also mentioned in the academic literature by Friedman, where she asserts these values to be implicated in the design of technology (Friedman et al., 2017, 2013; Friedman, 1996). However, not every interviewee discussed the values implicated in the design process. For example, dependency and trust were mentioned by IC6; *if I think on the top of my mind about ethical and moral values or human values, that goes during the project development. So obviously, if I talk about trust and dependency, so yeah, it's a small team, and we have to rely on each other.* In academic literature, trust among team members in an institution is shown to positively affect task performance, team satisfaction, and relationship commitment (Costa et al., 2001). However, these values did not seem to have moral import or implicated in the design process. Implicating trust in technology means that the users should be able to have easy and refined control about what personal information is made to others (Friedman & Kahn Jr, 2002). While trust is an important value held by

people, its implication in the technology design was not identified in the analysis.

Similarly, other values identified in the analysis of the interview were commitment, timeliness and sincerity. These values were what the interviewees believed that guided their work ethics. For example, in academic literature, commitment is defined as

“commitment to support the goals of the organization” (Angle & Perry, 1981)

“a force that stabilizes individual behaviour under circumstances where the individual would otherwise be tempted to change that behaviour.” (Brickman et al., 1987).

Based on the above definitions, it was analysed that interviewees valued commitment to meet the organisational goals and stick to the ideas and proposals despite the challenges, time and money: IC1: Commitment to what you claim to be able to deliver, like saying that you're committed to the requirements; IC3: if you feel like that, your idea is going to bring some more value to the company, feel free to share it, but you should also be committed to it.

The findings show that for interviewees, a few moral values are indeed implicated in system design while a few other values were more inclined towards work ethics, which is beyond the scope of this thesis.

The design phases in the analysis were identified as follows:

1. Client requirements/problem identification/idea proposal
2. Design requirements/feasibility analysis
3. Stakeholder identification
4. Production process of the product/service

The variations in the first step of the design phase mostly depended on the type of company and the software development process [waterfall, agile]. For instance, the interviewees who worked for a client-based company often started the design phase from the client requirements, while for product-based company, the engineering design phase begins with problem identification. According to van de Poel, the first phase of an engineering design process entails requirements based on intended use of the technology and the wishes of the client or user (van de Poel, 2009), which was indeed found in the analysis. The exact design process differed from interviewee to interviewee and that there were additional stages such as developing a prototype; IC1: you will be paid some small amount to develop a prototype. IC5: Someone used to be in my team had this idea and then developed it in a few months like developed a nice proof of concept with someone else. According to van de Poel, the prototype testing could be relevant to point out whether values are embodied in the design process and whether there could be unexpected consequences of the product or service (van de Poel, 2009). For the interviewee, the purpose of prototyping is to convince the client that the engineering team is sufficiently capable of building an actual system: IC1: It's basically that proving to the customer that you are capable of something of the bigger system.

The analysis identified that a few moments where conflicts and trade-offs concerning values were found to occur during the design requirements phase: IC2: when the more requirements come in, okay. Then they actually start to oh, this is a possibility that can happen. Could we do that? Is this possible? So then, with one possibility, 100 possibilities arise.

The conflicts were identified as **timeliness**: whether to deliver the project on time or **increase technical enhancements**: make the project technically advanced, provided the cost remains the same. In cases where the cost would be affected due to technical advancement, the decisions between **prioritizing project delivery** or **cost** were made by the engineering team in

discussion with management. Another trade-off was identified as their **commitment** towards the company and their **aspirations to make their project technically better**; between **enhancing user experience** and **timeliness**: completion of the project. As mentioned before, Friedman's list of values does not indicate that commitment, user experience and project delivery are values that can be implicated in the design process. These conflicts were identified to be confliction of personal and technical values for the interviewees. The reasons for this were also quite varied. Some interviewees mentioned that the involvement of moral values holds little importance to them in the design phase of the product. Another interviewee held the view that all the operations of the company, including engineering, revolve around a set of fixed values: IC3: Our company as a whole, it has defined six values that it runs on[...] that since these are the values that are ingrained in our system, most of the things that we decide, be it the problems, be it the solution, whatever we are thinking of, this somehow revolves around these things only. Another interviewee straight up denied having to face any decision-making for moral values. IC1: It's not our responsibility. It's not part of our job description as we don't really follow.

The analysis showed that the perceived significance of moral values (and the conflicts thereof), were lower than their concern with technical values in design. The following factors can be identified behind that.

1. The decision making behind the involvement of moral values depended upon business principles, policies, leadership and managers.
2. The belief of interviewees that their company would never ask them to develop something which violates moral standards of the stakeholders involved.

In conclusion, the interviewees seem to be aware of moral values, and experience moments of trade-offs with values such as timeliness,

increment in technical capabilities and financial aspects during the design phases.

4.2 Emotions

During the interview, all the emotions mentioned by the interviewees were grouped in a category named “emotions”. In the first phase of coding, 20 emotions were found throughout the transcripts. However, after the transcripts were evaluated multiple times, the number of emotions were reduced to 13. These emotions were the ones that were explicitly mentioned by the interviewees and can be found in table 2 below. The second column from left lists all emotions that were mentioned in the transcripts. The next column lists the total amount of times each emotion was mentioned, and the third column lists the interviewees who mentioned the emotion in each row. For example, the emotion happiness was coded nine times and was mentioned explicitly by five interviewees.

Table 3 Emotions as described by Interviewees

Sr. No.	Emotions	Total number of times each emotion was mentioned	Interviewees
	Happiness	9	IC1, IC3, IC5, IC8, IC9
	Frustration	9	IC1, IC2, IC8
	Satisfaction	5	IC1, IC3, IC9
	Anger	2	IC3, IC6
	Sadness	2	IC1, IC9
	Powerful	2	IC3, IC8
	Intrigue	2	IC8
	Boredom	2	IC1, IC5
	Disappointment	2	IC1, IC4
	Guilt	1	IC9
	Anxiety	1	IC6
	Helplessness	1	IC2
	Excitement	1	IC5
	Compassion	1	IC9

From the table, it can be observed that happiness was mentioned the most while guilt, anxiety, helplessness and excitement were mentioned the least. Based on the literature study, guilt, shame, regret, remorse, anger, compassion were found as moral emotions (Haidt, 2003; Kroll & Egan, 2004). As per table 1, guilt and compassion are the moral emotions that are in line with the academic literature which was experienced by one interviewee with respect to moral values in engineering design. According to Eisenberg, guilt can be an important emotion for motivating moral behaviour (Eisenberg, 2000). The interviewee's retrospection of how he would feel if the technology is misused shows that he is capable of reflecting upon the misuse of technology.

IC9: And essentially, for me, it's the same, something that you have built. If it's being misused in some way, then the first thing is you definitely feel guilty… Thinking of the fact that you could have made it a bit better, so that this could not have been misused in this way.

The interviewee's emotion also displayed his emotional sensitivity towards the plight of other's suffering, hence showing compassion.

IC9: you never know who the customer is, never see his or her face, or you never even talk to them. But then you know, you have that connection that okay, in some way you are protecting this person in your own way. So maybe that kind of emotional connection can be said… A person has a limited amount of money and his credit card gets stolen. And that is being, like literally wiped out of his entire money. What do you think happens to that person? Maybe that person is not that affluent, and that was the only money that he had to be used. And then that goes away. It's depriving him of doing a lot of things, right. These are the things when you actually think of it you tend to relate because eventually these are things that can happen to you as well.

Haidt also classifies anger as a moral emotion (Haidt, 2003). He described anger as a "feeling of indignation towards those who violated moral

standards, along with desires to redress the wrongdoing" (Haidt, 2003). Table 1 shows that two interviewees mentioned anger emotion. However, the antecedent of anger emotion for IC3 was because of idea rejection, and the antecedent of anger emotion for IC6 was the lack of communication. Both the antecedents do not violate the moral standards of the interviewees and therefore their anger emotion cannot be classified as moral emotion.

The context in which other interviewees mentioned other emotions depended upon the events they experienced in their job. These events were repeatedly coming up from each interviewee and are stated below:

- **Technical achievements**: the interviewees expressed that they experienced happiness in achieving technical improvements during their engineering design. On expanding upon improvements, the engineers described that their emotions such as happiness, excitement, satisfaction and intrigue were triggered when, for instance, their system design worked as desired, resolution of technical problems were accomplished, taking on new problems, and during moments where they accomplished successful data analysis. As engineers, the interviewees experienced the events mentioned above frequently.
- **Contribution**: Additionally, the engineers mentioned that when they observed that their contribution to a project is significant. The contribution of interviewees is characterised by moments when their ideas are selected by their team or by their superiors. The contribution is also characterised by moments when they realise that they are working on something they perceive is going to satisfy their clients or

users. The effect of contribution on the interviewees results in experiencing emotions such as satisfaction and happiness.

A few illustrative quotes are provided below:

- IC9: They just bring **a smile** when you actually solve something.
- IC8: And when the system works that these are the **happiest times**.
- IC5: Yeah, **makes me feel good**. Although, although it may be, it is very personal.
- IC3: **Happiness**, the **satisfaction** they are, I'd say outcomes of whatever your ideas go. If your idea got selected, definitely be **happy**…
- IC8: So, I would say, in the beginning, it felt very **intriguing**. Like, I suppose initially, I got user data, and there was a huge ton of data…
- IC1: It sorts of makes you very **satisfied** and **happy** to know that what you are working on today is going to go on somebody's table tomorrow….

The interviewees mentioned that they also experienced emotions such as frustration, boredom, disappointment, unhappiness and anxiety. On questioning about the events and moments where they experienced the emotions mentioned above, they stated the events such as ideas getting rejected, unavailability of resources they need, reduction of productivity and repetitive work.

A few illustrative quotes are provided below:

- IC8: A lot of **frustrations** came into place when we did not have any resource…
- IC3: There were no flaws to it, but somehow it got rejected, you will be **angry**…

- IC1: **Bored, disappointed, unhappy**. Your ego takes a big hit. But that is how companies work.
- IC6: So, it makes you **angry**, it makes you **anxious**, and it makes you a little bit impatient in front of your peers that they are not understanding what you are trying to explain to them. So, these are some hard, you know, hardcore emotions that come out of you when, when people are unable to understand your perspective.
- IC5: Novelty is essential or that novelty problem-solving. And if you don't have any of that, I think, yeah, I think then it becomes a little bit tedious. So, a little bit **boring**, a little bit repetitive.

In the academic literature, emotions which are tied to achievement activities and outcomes are known as achievement emotions (Pekrun, 2006). These achievement emotions can be classified as activity-related emotions and outcome emotions (Pekrun et al., 2006). For interviewees, the antecedents of happiness, satisfaction, intrigue were the outcomes of achievements (outcomes) and contributions (activity). Furthermore, emotions often such as sadness and anger occur during rejection episodes, and these episodes include rejection of ideas (Leary, 2015).

Moreover, emotions also serve as antecedents, mediators, moderators, and consequences of interpersonal interaction (Planalp & Rosenberg, 2014). Based on this information, the rejection of ideas by team and superiors as well as occasional disagreements with management over technical aspects can be considered interpersonal interaction and these interactions were considered as consequences of emotions such as frustration, anger and anxiety. Moral emotions, by their very definition, are emotions that "are linked to the interests or welfare either of society as a whole or at least of persons other than the judge or agent". The interviewees seem to experience these emotions during moments that affected them through achievements and contributions or due to interpersonal interaction. Both

the factors do not seem to incline towards moral interests, towards society or other humans.

4.3 Perception of Emotional Influence in Engineering Design

The interviewees seem to perceive emotional influence in engineering design in a varied number of ways. Some interviewees were against the proposition of emotional reflection in engineering design, including reflection upon values. The effect of emotions on decision-making was perceived as negligible by some interviewees, while for some, it seemed important. The following table reports the findings concerning the perception of the interviewees towards involving emotions in engineering design.

Table 4 Perception of Engineers on Influence of Emotions

Interviewee	Perceived significance of emotions	Reason
IC1	Not significant	Engineers are at the lowest hierarchy. Seniors do decision-making. Decision-based on client requirements. Belief that company will never make unethical products.
IC2	Not significant	Seniors do decision-making.
IC3	Not significant	Seniors do decision-making.
IC4	Not significant	Decisions should be based on facts, not emotions.
IC5	No opinion	Depends on the culture of a company.
IC6	Significant	Emotions would help engineers reflect on moral values.
IC7	Not significant	Engineers should be rational beings.
IC8	No opinion	Depends on the culture of a company. Could play a role when problems are vague.
IC9	Significant	Emotions would help engineers imagine the risk that a user could face.

As the table suggests, it was observed that five interviewees displayed negative perception towards emotional reflection in engineering design. The factors behind the negative perception are also provided in the table. As can be observed, a common factor among the reasons behind negative perception among engineers was that the role of decision-making concerning moral values was attributed to the people who are at a more senior position than the engineers. The interviewees also mentioned company culture, client requirements, rationality as factors for the negative perception towards emotions.

- IC1: My emotions don't influence me… The company does influence me to deliver a better product.
- IC4: Emotion is not something you should be betting on. My opinion would be to not be very emotional. That part should mostly come from the people from sales from they should be the one pitching for those other than engineer because for engineer a good engineer is someone who can code better. You cannot hire engineers based on if they are emotional.
- IC5: I think that really depends on the culture of the company. Depends on yeah, how decisions are taken and, and how much you know, how much of your opinion is of value.

Two interviewees, however, mentioned that they perceive emotions as something that could be used as a tool for reflection on decision-making, which also involved, according to them, moral values. The interviewees mentioned that ***their feelings towards moral values are significant***, and it would undoubtedly affect the final product if their emotions are not considered.

- IC9: I think in this respect, maybe the answer would be more emotional than neutral… when I have attached emotional importance to something, it helps me to work better in that one and make sure that everything is in place, and nothing goes, I mean in a direction which it shouldn't go… an emotional attachment to something would make things better.
- IC6: we all are humans and the technicians that work, we are humans as well. So, their emotions, their values, it matters… their emotions and values if not taken care, it can actually kill the product without even anyone knowing how it works.

The above results could be attempted to explain by the description of institutions provided by MacIntyre's philosophy, as discussed in his book *After Virtue* (initially published in 1981). In his book, Macintyre wrote that "institutions are involved in acquiring money and other material goods; they are structured in terms of power and status, and they distribute money, power and status as rewards nor could they do otherwise if they are to sustain not only themselves, but also the practices of which they are the bearers. For no practices can survive for any length of time unsustained by institutions" (MacIntyre, 2007, p.194). MacIntyre described practices as "By 'practice' I am going to mean any coherent and complex form of *socially established cooperative human activity* through which *goods* internal to that form of activity are realised in the course of trying to achieve those *standards of excellence* which are appropriate to, and partially definitive of, that form of activity, with the result that human powers to achieve excellence, and human conceptions of the ends and goods involved are systematically extended" (MacIntyre, 2007, p.187). Elsewhere, software engineering is described to be a social activity which involves human involvement (Crawford et al., 2014). Thus, it can be argued that MacIntyre's institutions are software engineering companies, and his notion of practices can be applied to software engineering design process. In other words, the software engineering design process (practice) is an activity embedded in software engineering companies (institutions). Van der Burg and van Gorp argue that the design process (in this case, software engineering design process) is an institutionalised practice, where practitioners (in this case, interviewees) practice software engineering at a location where they earn money for their services (van der Burg & van Gorp, 2005). Because of this practice, the hierarchical relationship forms between the managers and their engineering team, which creates a difference in power, money and status between the participants in the said practice (van der Burg & van Gorp, 2005). The above literature could explain why some of the interviewees perceive emotions as insignificant because of seniors (managers) have the power of decision-making, including the decisions concerning moral values. Two engineers described

(moral) decision-making should be based on facts and that engineers should be rational can be explained by the philosophical theory of moral rationalism, which suggest that morality originated in reason alone (Gill, 2007). As such, it can be said that those two interviewees have a rationalistic view of morality, and that is why they think that facts should be the basis of decision-making and not emotions.

Some interviewees also mentioned the culture of the company as a reason for negative perception towards emotions. Emotions, and including moral emotions can sometimes be suppressed in organisations by managers, or even muted so that the organisational objectives outweigh values and norms (Lindebaum et al., 2017). Those interviewees' organisation may have a climate where moral emotions are discouraged so that necessary reflection of moral values in engineering design could be overlooked in order to achieve certain objectives. Therefore, their perception of involving moral emotions was found to be negative.

To conclude, software engineering is a human capital intense activity, and therefore emotions are an inescapable part of software engineering design (Crawford et al., 2014). Despite many emotions being experienced, the perception of emotional influence in decision-making concerning moral values was negative for most of the interviewees. The moral values were certainly involved during the engineering design phases and, interviewees seemed to have a fair amount of understanding towards the necessity of these values in design. However, the reflection on these values was influenced by managers, company culture and rationality. The values of the organisation also played a role with values involved during the engineering design phases. Citing the reasons mentioned above, the interviewees displayed little interest in making decisions concerning values and were focused more on technical issues.

Since all the sub-research questions have been answered, the main research question can be answered, which is provided in the next chapter.

5. Discussion

The main research question for this thesis was the following:

What is the role of emotions for engineers working in the software engineering companies during the moments of value decisions in engineering design?

As per subsection 4.1, several emotions were experienced by the interviewees. Despite, those emotions, it can be said that for our interviewees, moral emotions were not experienced for eight out of nine interviewees. The result points out that for the reflection of moral values and the decisions thereof, moral emotions did not play a role. Instead, rationality, the responsibility of managers, client requirements and belief that the company will not intentionally harm users, were identified from the interviews. These were also some factors present in the literature, as explained throughout chapter 4. It appears that the role of emotions for values is negatively perceived by the interviewees, while the aforementioned factors play a greater role for the interviewees. It was found in the literature that a way to achieve moral sensitivity was to let engineers and developers sympathise with the potential users of technology. This sensitivity was observed to be present in one interviewee. It could be concluded that moral emotions benefitted him to strive for moral values and mitigate risk as much as possible during the engineering design phases.

As seen from the transcripts and the analysis, a few engineers prioritized rationality over emotions. For them, engineers should not be emotional because facts and numbers provide a better picture of right and wrong. Their point of view goes along with the Dual Process Theory, which is described in the literature study. According to this theory, people perceive reality through two distinct systems, where System 1 is emotional and

spontaneous, and System 2 is rational (Kahneman, 2011). This theory is a principle theoretical framework in empirical decision research. In metaethics too, rationalistic and sentimentalist view of emotions (Borges, 2004; Hume, 2003) prevails where the similar dichotomy between emotions and rationality is observed. The mindset of the interviewees seems to coincide with System 2/rationalistic view of emotions in terms of decision-making concerning moral values in engineering design. They were not able to view emotions as a viable source of reflection for morally acceptable values, which the new approaches to emotions suggest. In these approaches, emotions, and more specifically, moral emotions are argued to be justified and rational and therefore, do not fit into the dichotomy discussed above (Roeser, 2012). A few other reasons why moral emotions among interviewees did not seem to play a role in value decisions in the design process are hierarchy, company culture, a well-established code-of-conduct/company values that guide the operations of the company and policies implemented by governing institutions. This means that technology is always going to be laden with values, implemented by policymakers or management or any other stakeholders. However, it should not undermine the pivotal role of engineers and more importantly, their moral emotions towards value decisions. This is because engineers play a pivotal role in the design of technology, and they should not be excluded from the responsibility of designing morally acceptable technologies. Since a design process is concerned with things that are yet to be produced, engineers should embrace forward-looking responsibility and the emotions that are involved with the responsibility (Roeser, 2012). Several interviewees mentioned their responsibility being limited to technical roles, and they either don't want to or are not encouraged to transcend their formal role as an employee. This indicates that there is a codification of responsibilities among professionals, to which Roeser disagrees (Roeser, 2012). She and other moral philosophers argue for the development of context-sensitivity in the design of technologies (Dancy, 2004; Roeser, 2012), and this type of sensitivity requires moral emotions (Roeser, 2006). Since technologies are nevertheless going to be value-

laden, this sensitivity would encourage engineers to evaluate morally acceptable values that should be incorporated into engineering design. In this way, moral emotions do play a role in value decisions. This kind of role was hinted among the answers of IC2 and IC9, both of which displayed context-sensitivity during their respective design processes.

Desmet and Roeser argue another role that moral emotions play in technology design. They argue that the design of technology evokes emotional responses among the designers and these emotions should be taken into account because they can draw attention to significant values that can be included in the design (Desmet & Roeser, 2014). This argument matches well with the analysis, where it was found that interviewees experienced emotions to technical values of the design, such as **increasing user experience** and **delivering the project on time (timeliness)**. Another role that emotions play is that it facilitates the development of the imaginative capacities of the engineers, such as imagining the potential misuse of the technologies (Desmet & Roeser, 2014). This role of emotions should help the engineers to make well-developed decisions concerning morally acceptable values. One interviewee (IC9) displayed such imaginative capacities and mentioned striving hard to incorporate moral values in the design process so that the users can be protected from potential misuse. By drawing attention to maximising positive values and minimizing the negative values with the help of their emotional responses, engineers should assume responsibility to oversee and influence the properties of the technological product or service more than any other stakeholders such as managers and stakeholders (Desmet & Roeser, 2014; van der Burg & van Gorp, 2005).

A few moral philosophers argue that embracing responsibilities should make people virtuous [someone who can avoid extreme responses and steers a wise middle ground], provided that they have sufficiently developed emotions (Döring & Feger, 2010; Roberts, 2003; Williams, 2008). In the context of engineering design, the responsibilities mentioned

earlier, that is, context-sensitivity, and drawing attention towards moral values, both of these require that engineers should experience moral emotions in design. With moral emotions, engineers would become sensitive enough to decide morally acceptable values that society needs from a technological product or service. Instead of being abstracted towards the end-use of the product or service, as IC1 pointed out, moral emotions would facilitate transcendence to realise unforeseen, unquantifiable consequences of the technology (Roeser, 2012).

However, one cannot ignore the role of hierarchy in distributing responsibility, and from the analysis, it was found that the decision concerning values are attributed to stakeholders other than engineers. Looking at the analysis, moral emotions were not identified as something that interviewees consider significant for value decisions in engineering. Instead, the hierarchy between engineers and managers (or CEO), belief (the company will never make a product from harming its users) and mandatory requirement for inclusion of values through code-of-conducts, guidelines for engineering design and policies were identified to be major influencing factors for value decisions. Hierarchy is a form of organisational structure which is known to influence the decision-making abilities of employees (Abumandil, 2016). It shapes the responsibilities and behaviour of the employees in the organisation (Gilbert, 2012). Individuals who hold positions of managers and executives are responsible for making decisions at a centralised organisation (Abumandil, 2016). The argument by Abumandil could explain why interviewees displayed negative perception towards the significance of emotions for engineering design since the responsibility of including values in engineering design is attributed to management or policymakers, and those stakeholders have more hierarchy than engineers. Thus, it could be said that organisational structure might have a moderating effect on interviewee's responsibility on value-decisions and to some extent, affected their moral emotions. As a confounding variable, the organisational hierarchy affected the findings of the research.

Hence, even an engineer who has well-developed moral emotions, imaginative capacities, context-sensitivity, is limited with value-decisions unless she or he is included in value-decisions during engineering design. The responsibility of critically reflecting upon moral values should be given to engineers, where their moral emotions can facilitate observing unforeseen consequences of technology, during the initial phases of engineering design, where value-discussion takes place (c.f. van de Poel, 2009). By having such responsibility, it should be possible for engineers to realise the significant role of moral emotions in engineering design, which was observed to be undermined by the majority of interviewees.

5.1 Management Implications

There is a hierarchical gap between engineers and their managers in organisations. Due to this hierarchical gap, the responsibilities of engineers and managers are different. However, in the context of this research, the following management implications are pointed out. Management should distribute some of the responsibilities of value decisions to engineers and encourage them to include ethical-emotional reflection during the design process of the technological product or design (Roeser, 2012). Furthermore, engineers should also be trained as virtue ethicists to make better use of their imaginative capacities and accordingly bring morally acceptable values in their design (van der Burg & van Gorp, 2005). The emotional responses of engineers towards a technological product, activities that are enabled or supported by that technological product and technologies can be both pleasant and unpleasant (Roeser, 2012). The management should seriously acknowledge these emotional responses for value-decisions along with the engineers. Desmet and Roeser argue that emotions play an important role in directing towards values that are significant for the well-being of an individual and the society (Desmet & Roeser, 2014). Management should allow for the inclusion of emotions along with scientific, numerical methods during the engineering phases to produce morally acceptable and humane technologies.

The role of discussion phase during the design phase, where the emotional and ethical concerns of a technological product or service are taken into account, discussed and decision-making is performed during the phase is another implication of this research. This is because some interviewees indicated that during meetings, engineers are encouraged to bring up their concerns regarding the technical aspects. As such, making such phase mandatory where imaginative capacities and drawing attention to values of engineers should be discussed should result in overall morally acceptable design. Such activity also fits well with arguments from scholars

who have developed methods to enable reflection of technologies (Boenink et al., 2010).

5.2 Limitations and Future Research

The theories studied for this research were taken from psychology, philosophy, metaethics, engineering ethics and organisational management. This process added a higher degree of challenge to form a fitting theoretical narrative in a way that should explain the findings of this research. The challenge was met with the best possible effort; however, as a thesis at the master's level, the limitation could entail a lack of clarity in the narrative. Future researchers are encouraged to expand the empirical research on role moral emotions in engineering by selecting a limited number of factors identified in this research. Furthermore, the cognitive role of emotions and design-driven by emotions are a few approaches provided by Roeser and colleagues in engineering arena (Roeser, 2006, 2009; Desmet & Roeser, 2014; Roeser, 2012, 2010).

Furthermore, the qualitative nature of this research reduces the generalisability and reliability of the findings. The issue of subjectivity, as well as contextual ramifications, can raise questions on the quality and trustworthiness of qualitative results (Leung, 2015). To the best of my knowledge, the guidelines and protocols of the interview procedure were rigorously followed while also avoiding the pitfalls with the help of literature as described in chapter 3.

The research objective was focused on determining the role of moral emotions in value decisions in engineering design phases which were found out through analysis and literature. However, moral emotions play a role in an individual's life beyond moral values. Moral emotions are several, and each has various antecedents and consequences in management sciences (c.f. Greenbaum et al., 2020). Future researchers interested in expanding research on moral emotions may consider taking insights from the literature of intuitionists perspective (e.g. Haidt, 2001; Sonenshein, 2007). This perspective is increasingly studied in recent literature concerning management sciences (Andersen et al., 2015; Provis, 2017;

Zuber & Andersen, 2016). An intuition includes an emotional reaction that facilitates individuals to react to events spontaneously and efficiently (Greenbaum et al., 2020). Huang and colleagues have demonstrated that people sometimes act on their moral emotions without going through their feelings or behaviours (Huang et al., 2019). Along these lines, future researchers should explore the scope of intuitive perspective concerning moral emotions among engineers in organisations.

Another limitation of this research is that the sample for this study was limited to engineers who were new to working for organisations. As such, the role of moral emotions for future engineers who are still receiving engineering education was excluded from this research. Roeser suggests introducing courses that enhance and imaginative and emotional capacities of future engineers may facilitate realisation among engineers to transcend their formal role as future employees (Roeser, 2012). Future researchers should investigate the scope of moral emotions among engineering students and develop theoretical perspectives on the implementations and effectiveness of such courses.

6. Conclusion

This exploratory thesis set upon to explore the role of moral emotions in value decisions among engineers working in organisations through interviews. While it was found that moral emotions among engineers were present and that they are motivated to improve the specifications of product or service, the role of moral emotions in engineering design was found to be severely undermined. The factors that were found to affect this were found to be engineers not responsible for the moral acceptability of the technology, as well as, other stakeholders making such decisions. Furthermore, hierarchy, values of organisation, policies and a firm belief that organisation will never allow the development of unethical product were also found to affect the under-developed significance of moral emotions in engineering design. Rationalistic approach towards emotions still dominate as the mindset of engineers, and this should be transformed to make engineers realise the cognitive role that emotions should play in their engineering design, along with rational and scientific investigation of risks and moral values.

An objection might arise that values such as privacy, human welfare, user experience, among others already exist without the intervention of the emotional side of engineers. However, as mentioned earlier, technology will always be value-laden. However, the emotions of engineers will enable critical reflection of unforeseen misuse of technology which could be avoided during the engineering design, if engineers include values that protect an individual as well as the society. Of course, technologies are created and are evolved for the well-being of society. However, this also means that the negative aspects of technology can be exploited. Popular moral dilemmas concerning technology such as which stakeholder is responsible if there is a misuse of self-driving cars (analogous to trolley problem) or the rising case of depression due to social media addiction among teenagers and young adults, or the widely covered Cambridge

Analytica case are examples of why engineers and other stakeholders alike need to use their moral emotions to minimize this kind of misuse of technologies.

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Appendix A

Table 5 Relationships between function and components of emotions and the organismic subsystems (Scherer, 2001)

Emotion Function	Emotion Component	Organismic Subsystem
Evaluation of objects and events	Cognitive component	Information Processing
System Regulation	Peripheral efference component	Support
Preparation and direction of action	Motivational component	Executive
Communication of reaction and behavioural intention	Motor expression component	Action
Monitoring of internal state and organism-environment interaction	Subjective feeling component	Monitor

Appendix B

Table 6 Twelve common mistakes in making value trade-offs (Keeney, 2002)

No.	Pitfalls	Conceptual Description
1.	Not understanding decision context	One should know what the decision is and what it intends to accomplish. It is also beneficial to realise the time scale for the decision and whose perspective the state value trade-offs are meant to represent.
2.	Not having measures for consequences	For reasonable value trade-offs, one needs to also address the consequences and the proper way to do it is to have measures for them.
3.	Using inadequate measures	In order to realise the consequences, one should have adequate measures too.
4.	Not knowing what measures represent	Value trade-off will be reasonable when the it is known what the measure is representing.
5.	Making trade-offs involving means objectives	It is convenient to make value trade-offs among fundamental objectives. These objectives state the reason for interest in the problem.
6.	Unwillingness to swap as a value trade-off.	The indifferent consequences that define and are defined by value trade-offs will result in equal satisfaction or dissatisfaction in either of the consequence, but it does not mean that one would be willing to swap one consequence for the other.
7.	Trying to calculate correct value trade-off	Value trade-offs must be based on value judgement.

8.	Assessing value trade-offs independent of range of consequences	Similar to point 2. Value trade-offs must not be assessed without considering range of consequences.
9.	Not having value trade-offs depend on where you start	In case where the question is about the risk aversion (such as in technologies), it is unreasonable to assume that value trade-off between units of measurements can be extrapolated over the entire range.
10.	Providing conservative value trade-offs	Conservative value judgements do not lead to conservative decisions.
11.	Using screening criteria to imply value judgements	Value trade-offs implied by screening criteria are often inconsistent with your true values.
12.	Failure to use consistency check in assessing value trade-offs	Eliciting value judgements could be biased and filled with random errors, and should be avoided by redundant assessments to see if it represents their interests.

Appendix C

Table 7 List of Categories developed for coding

Category	Number of codes in each category
Value	24
Emotions	18
Engineering Design Phase	15
Trade-offs	6
Perception of interviewees on influence of emotions	4
Software development process	3
Moments of value trade-offs	3