WIRTSCHAFTS UNIVERSITÄT WIEN VIENNA UNIVERSITY OF ECONOMICS AND BUSINESS

DISSERTATION

Bridging ethics and technology design: A value-based approach to IT innovation

submitted by

Kathrin Bednar, MSc MSc

1st examiner:	Prof. Sarah Spiekermann-Hoff
2nd examiner:	Prof. Peter Hampson
3rd examiner:	Dr. Stephan Leixnering

Vienna, August 2023

Acknowledgements

I am deeply grateful to all those who have contributed to the successful completion of my PhD journey. I am particularly thankful to my supervisor, Sarah Spiekermann-Hoff, whose high expectations pushed me in my academic thinking and helped me become an independent researcher. While at times our discussions were intense, I am especially grateful for her helpful insights on how to find the best story when writing a paper, seeing the big picture and not getting stuck in details.

I extend my appreciation to the members of my thesis committee. Peter Hampson has contributed insightful feedback and inspiring research ideas and was an invaluable source of encouragement in the final stages of my PhD thesis. I am proud that my interdisciplinary thesis committee also includes the organisational perspective of Stephan Leixnering, who has opened my eyes with his critical questions and his emphasis of the wider impact of my PhD research.

My sincere thanks go to my colleagues at the Institute of Information Systems and Society, who welcomed me when I joined the team and accompanied me all through my time there. Jana, you always shared your wisdom and laughter with me and I have learned so much from you. Till, thank you for your humorous Berlin spirit of taking it easy and appreciating the important things in life. Sabrina, you have been a mentor to me and helped me believe that I could achieve great things. Esther, Sushant, Olha, Dina, and David, thank you for all the nice lunches and stimulating discussions.

To my friends and family, I wouldn’t have made it without all of you. Thank you for always listening, for your encouragement and your support. David F., Flo, Ingrid, and David W., thank you for sharing your PhD experiences with me, it has made my own journey easier. To my parents and sisters, thank you for believing in me and supporting me in pursuing my interests and finding my own path. Lukas, you were always there for me. Thank you for keeping your seat through the highs and lows of this rollercoaster ride, life is just better with you by my side. And finally, Helena, you inspire me to see the world differently every day. I hope that my enthusiasm for science and research encourages you to always stay curious about humans, technology, and the world.

Kathrin Bednar,

August 2023

Abstract

Background and Motivation. Information technologies (IT) have many beneficial uses, but recent developments have raised substantial concerns regarding the impact of technologies on values such as privacy and equality. With emerging technologies such as biotechnologies, we face ethical issues but also implications on what it means to be human itself. Recent approaches suggest the consideration of values in the technology design process to go beyond the traditional IT innovation focus on technological capability and market needs. Value-oriented methods that guide the identification of values and their consideration throughout the technology design process are numerous and diverse, but have been criticized for lacking an ethical foundation.

Research Aim and Method. In the empirical research project that I present in this dissertation, I investigate whether the perspectives of utilitarianism, virtue ethics, and deontology can fill this gap and provide an ethical grounding for values in technology design. My research aims focus on 1) exploring how the three ethical perspectives differ in the value ideas they inspire, 2) comparing the resulting value ideas to values captured in a traditional technology roadmap, and 3) investigating how the ethical perspectives and identified values influence the overall evaluation of a technology product resulting in an investment decision. In a mixed-method study, I analysed data from student participants who critically analysed three IT products (a bike courier app, a smart teddy bear, and a telemedicine platform) after coming up with a technology roadmap.

Results. Results from my qualitative and quantitative analyses show that ethical perspectives fundamentally influence the identification of values in the technology design process. Regarding my first research aim, each ethical perspective showed a unique contribution to the identification of values: Utilitarianism inspired a high number of value ideas that covered various value dimensions, virtue ethics complemented this with a focus on morally good character traits, i.e., virtues, and deontology re-validated important values and virtues with a focus on social values. Regarding my second research aim, the ethics-based approach significantly extended the set of values considered in the technology roadmap, which focused on technical and economic values, by considering other value dimensions such as individual and social values. What is more, it helped to identify possible harms that could arise from the IT product's wide-spread use for various affected stakeholders. The exploration of my third research aim resulted in the observation that the participants showed an overall optimistic view of the respective technology that they had analysed and largely ignored critical value-based arguments that they had formulated, indicating a pro-technology innovation bias.

Conclusions and Implications. Together, these findings contribute new insights on how different ethical perspectives play out in an empirical setting and suggest important implications for theory, research and practice. Next to the major insight that ethical perspectives foster creative thinking around values, my findings provide an empirical argument for a pluralist ethical basis for value-oriented technology design but also motivate more research on how ethical principles can best be translated into specific practical contexts. In my outlook on future developments in technology design, I draw on different views of the human-technology relation and close with a prospective shift to a more flexible view of the interrelatedness of humans and technology.

Table of Contents

LIST OF TABLES V

LIST OF FIGURES VII

LIST OF ABBREVIATIONS VIII

1 INTRODUCTION 1

1.1 Motivation for Considering Values in Technology Design 4
- 1.1.1. Reported Negative Effects and Related Values 5
- 1.1.2. Locating the Responsibility 6
- 1.1.3. Considering Values in Technology Design 9

1.2 Research Gap: An Ethical Framework for Value-based Idea Generation and Evaluation 11
- 1.2.1. An Ethical Framework for Values 12
- 1.2.2. Value-based Idea Generation and Technology Roadmapping 15
- 1.2.3. Value-based Idea Evaluation and Decision-Making 17

1.3 Research Aims and Scope 18
- 1.3.1. Overview of Research Questions 18
- 1.3.2. Aims and Scope 19

1.4 Structure of the Thesis 20

1.5 Related Publications 22

2 THEORETICAL BACKGROUND: VALUES IN TECHNOLOGY 25

2.1 IT Innovation and Design 26
- 2.1.1. Creativity as Common Ground 27
- 2.1.2. Consideration of Risks and Stakeholders 28
- 2.1.3. Shifting Paradigms in Technology Design 30
- 2.1.4. Envisioning Ethical IT Innovation 31

2.2 The Concept of Values 33
- 2.2.1. Defining Values 35
- 2.2.2. Locating Values Within the Subject-Object Relation 37
- 2.2.3. Values Have Moral Import 39
- 2.2.4. Intrinsic/Instrumental Values and Virtues 41
- 2.2.5. Sustainability and Values 42
- 2.2.6. Values: "Big Words" Bridging Technology Design and Ethics 43

2.3 Value-oriented IT Approaches and Current Challenges 45
- 2.3.1. Top-down Challenges: The List-based Approach to Values 45
- 2.3.2. Bottom-up Challenges: Value Identification in Need of Ethical Commitment 48

2.4 Candidates for Providing an Ethical Foundation for Values 51
- 2.4.1. Utilitarianism: Weighing Beneficial Against Harmful Consequences 52
- 2.4.2. Deontology: Addressing Moral Obligations 55
- 2.4.3. Virtue Ethics: Supporting Good Character Traits 57
- 2.4.4. Comparing Ethical Perspectives on Values 60

2.5 Bringing Values to IT Innovation Practices 61
2.5.1. Technology Roadmapping 62
2.5.2. Traditional versus Value-based Roadmapping 65
2.5.3. IT Investment Decisions 70
2.5.4. Traditional and Value-Based IT Innovation Strategies 71

3 METHOD 75

3.1 Procedure and Instructions 76
3.1.1. Preparation and Task Instructions 76
3.1.2. Capturing Participants' Ideas 79
3.1.3. Follow-up Study 80

3.2 Sample 81

3.3 Case Studies and Investigated Technologies 81
3.3.1. Bike Courier App 82
3.3.2. Smart Teddy Bear 84
3.3.3. Telemedicine Platform 85

3.4 Data Coding and Content Analysis 86
3.4.1. Assessment of Intercoder Agreement 86
3.4.2. Category System Based on Labels for Participants' Ideas 88
3.4.3. Values, Virtues and Other Category Groups 89
3.4.4. Value Classes 92

3.5 Resulting Dependent Variables 93
3.5.1. Quantitative Value Creativity Variables 93
3.5.2. Acknowledged Stakeholders 95
3.5.3. Net Value Effects and Standardized Net Value Effects 96
3.5.4. Investment Decisions 97

3.6 Statistical Analyses 99

4 RESULTS 101

4.1 How do the Perspectives of Different Ethical Theories Influence Value-based Thinking in Technology Design? 102
4.1.1. Frequent Values 102
4.1.2. Intrinsic Values, Instrumental Values and Virtues 105
4.1.3. Sustainability Dimensions 107
4.1.4. Conclusion: A Pluralist Ethical Foundation for the Value Elicitation Process 110

4.2 How Do Ideas Generated by a Value-based Approach Compare to Ideas Captured in Traditional Technology Roadmapping? 112
4.2.1. Overview of Results 112
4.2.2. Fluency of Value Ideas 113
4.2.3. Fluency of Product Ideas 114
4.2.4. Flexibility of Value Ideas 115
4.2.5. Originality of Value Ideas 117
4.2.6. Anticipated Adverse Effects 118
4.2.7. Considered Stakeholders 119
4.2.8. Conclusion: Ethics Inspires Creative and Value-oriented IT Innovation 122

4.3 How Does Value-Based Thinking Influence IT Investment Decisions? ... 123
4.3.1. Decisions For/Against Investment ... 124
4.3.2. Anticipated Value Effects ... 126
4.3.3. Value Effects Driving Decisions For/Against Investment ... 128
4.3.4. Qualitative Reasoning Behind Investment Decisions in the Telemedicine Platform ... 130
4.3.5. Follow-up Study: Value Effects and Design Adaptations ... 133
4.3.6. Weighing Value Costs and Benefits Versus Theory-specific Tendencies ... 135
4.3.7. Conclusion: Critical but Biased Decisions ... 137

5 DISCUSSION AND OUTLOOK ... 139

5.1 Implications for IT Innovation Practices and Value-oriented Design ... 139
5.1.1. A Value-based Approach to System Design ... 140
5.1.2. Avoiding Harms versus Creating Benefits ... 143
5.1.3. Value Elicitation from Context Versus List-based Approaches ... 144
5.1.4. Adding Value to Technology Roadmaps ... 147
5.1.5. Influence of Specific Ethical Perspectives ... 148
5.1.6. Biases in Early-stage Investment in New IT Products ... 148

5.2 Limitations and Future Research ... 150
5.2.1. Study Design ... 150
5.2.2. Restrictions of the Investigated Ethics-based Value Approach ... 152
5.2.3. Difficulties of Considering Ethical Implications ... 155
5.2.4. Evaluating Ideas for Technology Design ... 157

5.3 Outlook: Rethinking the Human-Technology Relation ... 159
5.3.1. Views of the Human-technology Relation ... 159
5.3.2. Where to Draw the Line? Body, Mind, and Technological Enhancements ... 161
5.3.3. Autonomy Reconsidered: Humans and Their Environment ... 163
5.3.4. Human Values and Technology ... 164
5.3.5. Looking Ahead: A Paradigmatic Shift? ... 166

6 CONCLUSIONS ... 169

6.1 Values as a Bridge Between Technology Ethics and Design ... 169

6.2 A Pluralist Ethical Framework for Value Elicitation ... 171

6.3 Increased Creativity and Biased Thinking in Traditional IT Innovation ... 173

REFERENCES ... 177

APPENDICES ... 203
Appendix A ... 203
Appendix B ... 204
Appendix C ... 213
Appendix D ... 227
Appendix E ... 245
Appendix F ... 246

List of Tables

Table 1. The realization of positive and negative values (adapted from Scheler, 1913-1916/1973, p. 26) 40
Table 2. Instructions and resulting data structure for the technology roadmap and ethics-based task 78
Table 3. Overview of investigated technologies 82
Table 4. Coding instructions for category groups assigned to the 2,119 original ideas 91
Table 5. Coding instructions for value classes 92
Table 6. Examples for net value effects and standardized net value effects 97
Table 7. Frequent values mentioned for each technology and ethical analysis 103
Table 8. Mean number of ideas separately listed for IT product and approach 113
Table 9. Overview of statistical effects of IT products and approaches 245
Table 10. Stakeholders mentioned in the participants' idea descriptions 120
Table 11. Correct predictions of individual investment decisions for the three case studies 126
Table 12. Investment decision patterns and net value effects for all teams (*N*=18) 131
Table 13. Comparison of values found in the present study with value themes from Jobin et al. (2019) 145

Tables in Appendices

Table A1. List of relevant publications by the author 203
Table D1. Intrinsic values 227
Table D2. Instrumental values 230
Table D3. Virtues 235
Table D4. Emotions 239
Table D5. Personal characteristics or abilities 239
Table D6. Product characteristics 240
Table E1. Overview of statistical effects of IT products and approaches 245

List of Figures

Figure 1. Research aims and tasks tested in empirical study of this thesis 19
Figure 2. A simplified view of traditional versus ethical innovation (adapted from Jha & Bose, 2016; Xiao, Califf, Sarker, & Sarker, 2013) 33
Figure 3. Value framework 34
Figure 4. Ethics-based value elicitation and resulting value framework (RQ1) 61
Figure 5. Schematic technology roadmap (Phaal, Farrukh, & Probert, 2004, p. 10) 63
Figure 6. Example for a technology roadmap (Albright & Kappel, 2003, p. 37) 64
Figure 7. Schematic value roadmap (Dissel, Phaal, Farrukh, & Probert, 2006, p. 1491) 65
Figure 8. Schematic value-based technology roadmap (adapted from Dissel, Phaal, Farrukh, & Probert, 2009, p. 48, and Dissel, Phaal, Farrukh, & Probert, 2006, p. 1491) 66
Figure 9. Procedure showing participants, case studies, preparation, and tasks 75
Figure 10. Overview of the coding process including developed category groups and value classes 87
Figure 11. Overview of innovation tasks and investment decisions 98
Figure 12. Share of instrumental/intrinsic values and virtues among the pool of value ideas aggregated for the three technologies 105
Figure 13. Sustainability dimensions underlying value ideas for all three technologies 107
Figure 14. Means with 95% confidence intervals for corrected fluency of value ideas 114
Figure 15. Means with 95% confidence intervals for corrected number of product ideas 115
Figure 16. Means with 95% confidence intervals for corrected flexibility (number of value classes covered). 116
Figure 17. Distribution of value classes among all value ideas aggregated from the three IT products 116
Figure 18. Means with 95% confidence intervals for corrected originality scores 118
Figure 19. Means with 95% confidence intervals for corrected number of ideas describing adverse effects .. 119
Figure 20. Means with 95% confidence intervals for corrected number of mentioned stakeholders 120
Figure 21. Share of investment decisions regarding the initial design after the technology roadmap and each ethical analysis for all three IT products 125
Figure 22. Net value effects across the three ethical analyses for all three IT products 127
Figure 23. Standardized means of net value effects across ethical analyses for all three IT products 128
Figure 24. Standardized means of net value effects for group decisions pro/against investment across ethical analyses for all three IT products 129
Figure 25. Development of investment decisions on the bike courier app prior to and after ethical analyses 134
Figure 26. Investment decisions of the three ethical perspective groups for the initial design (left) and the adapted design (right) of the follow-up study on the bike courier app 135
Figure 27. Section of a value cluster as presented by Spiekermann-Hoff et al. (2019), p. 13 141

Figures in Appendices

Figure F1. Instrumental/intrinsic values and virtues among value ideas for bike courier app 246
Figure F2. Instrumental/intrinsic values and virtues among value ideas for smarty teddy bear 246
Figure F3. Instrumental/intrinsic values and virtues among value ideas for telemedicine platform 246
Figure F4. Sustainability dimensions underlying value ideas for bike courier app 247
Figure F5. Sustainability dimensions underlying value ideas for smart teddy bear 247
Figure F6. Sustainability dimensions underlying value ideas for telemedicine platform 247

List of Abbreviations

ACM	Association for Computing Machinery
HCI	Human-Computer Interaction
ICT	Information and Communication Technologies
ISO	International Organization for Standardization
IEEE	Institute of Electrical and Electronics Engineers
IT	Information Technology
RQ	Research Question
STS	Science and Technology Studies
VBE	Value Based Engineering
VSD	Value Sensitive Design

"The history of ethics and IT ...

come together in the focal points design and values"

(Albrechtslund, 2007, p. 65)

1 Introduction

Technology shapes the world we live in. With increased capability and functionality, it no longer only determines the *safety* in living, the *comfort* in transportation, or the *efficiency* of tools and machines we use for economic and private purposes. Information technology (IT) influences the quality of *friendships*, the experience of *freedom of expression*, the acquisition and sharing of *knowledge* and the *security* of personal data. These examples show that there is a myriad of human values related to the design and use of technology that are highly relevant for individuals and societies. Technologies actively shape our social context (Brey, 2005) and mediate how we perceive our environment and thereby our relation to the world (Ihde, 1990). Contemporary scholars and philosophers of technology have long moved past the view that technology is "neutral" and technological development "inevitable" (Franssen, Lokhorst, and van de Poel 2009; Johnson 2015; Miller 2021). Instead, they argue that technologies "embody values" (van de Poel & Kroes, 2014) and "can be shaped … according to social and ethical values" (van den Hoven, Vermaas, & van de Poel, 2015b, p. 82). Every design represents an intention of use (Offermann, Blom, Bub, & Levina, 2010) and every design decision shapes the technology that will come into use. In order to secure an ethical and sustainable interaction of humans with technologies, we need methods that support an ethically aligned technology design. This thesis contributes empirical insights on how values can help to bridge ethics and design in IT innovation.

The innovation process is deeply rooted in the fundamental human capacity to create something new. This is important for our development as humans, not because innovation can be equated with progress, but because what we create influences who we are. In the words of Malafouris (2014), "we have been altering our own developmental paths by making and changing the material means by which we engage the world" (p. 140). This makes design an "inherently moral activity" (Verbeek, 2006, p. 368) and has pushed the consideration of values to the front in current technology design approaches (Friedman & Hendry, 2019; Shilton, 2018; Spiekermann, 2023; Spiekermann et al., 2022). Design forms an essential part in the innovation process (Jha & Bose, 2016; Xiao, Califf, Sarker, & Sarker, 2013). Yet, traditional IT innovation approaches mostly focus on technological capability and market needs, e.g., when employing technology roadmaps (de Alcantara & Martens, 2019; Phaal, Farrukh, & Probert, 2004; Vinayavekhin, Phaal, Thanamaitreejit, & Asatani, 2021). This focus falls short in at least two regards. First, it reduces the human-technology interrelation to technical functionality and aims at economic success by satisfying customer needs and beating competition (Kerr & Phaal, 2020). This ignores the wider impact that technologies have on directly and indirectly affected groups of people and the various values that are associated with this impact. Second, it implies a narrow view of risks of the envisioned technology and rarely takes into account that a technology design can endanger important values. This disregards reports of privacy breaches (Verizon, 2017) and negative effects on psychological and physiological well-being (Alonzo, Hussain, Stranges, & Anderson, 2021; Elhai, Levine, Dvorak, & Hall, 2016; Li, Lepp, & Barkley, 2015). Researchers as well as information systems practitioners have realized that they need to take these developments seriously and consider how a technology supports values as well as potential negative value effects *before* it comes into use. Ideally, this happens in the design process, when characteristics can still be adjusted (Meijer & De Jong, 2020; Taebi, Correljé, Cuppen, Dignum, & Pesch, 2014). The concept of values can guide this design process (Albrechtslund, 2007) by translating ethical principles into design requirements for a specific technology context, thus bridging ethics and design (Timmermans, Zhao, & van den Hoven, 2011).

Values are a useful concept in the design process as they can be used to represent consequences for affected stakeholders of a technology that we desire or seek to avoid in the form of value benefits and harms (Friedman, Kahn Jr., & Borning, 2006). Values are "qualities that are appreciated for contributing to or constituting what is good, right, beautiful, or worthy of praise and admiration" (de Graaf and van der Wal, 2008, p. 84). The consideration of a variety of values can support sustainability in IT innovation by expanding dimensions of sustainability beyond the protection of the natural environment. It has been argued that a technology's design should address not only *economic* (i.e., capital and long-term investments) and *technical* values (i.e., long-term usage and evolution of systems), but also *social* (i.e., social capital), *individual* (i.e., human capital and private good) and *environmental* values (i.e., natural resources; Penzenstadler & Femmer, 2013; Winkler & Spiekermann, 2019). Focusing on values in this way throughout the entire design process does not only support risk management, but opens up new ways in which managers and engineers can support human flourishing (Spiekermann, 2016).

There are values that often come up in public technology discourse and form core principles of related disciplines and fields of practice. Such values represent "central" themes (Agre 1997) of the field and have been referred to as *mainstream values* (Spiekermann, 2016). A good example for the information systems context is privacy, as it relates to a wide area of research of the past years (Yun, Lee, & Kim, 2019) and is considered a core issue of computer ethics (Stahl, Eden, Jirotka, & Coeckelbergh, 2014). It is an important step that values such as privacy along with other important ethical principles are now receiving wider attention in organisations, often in the form lists (Jobin, Ienca, & Vayena, 2019). However, researchers and scholars have emphasized that values and their (moral) relevance are highly context-specific (Hulstijn & Burgemeestre, 2015; Kroes & van de Poel, 2015; Le Dantec, Poole, & Wyche, 2009). Thus, considering established values is not enough: values have to be identified from the particular technology's context in an *empirical discovery* (Le Dantec et al., 2009) or *value elicitation* (Friedman, Hendry, & Borning, 2017; Pommeranz, Detweiler, Wiggers, & Jonker, 2012).

The past twenty years have seen a number of value exploration and design methods for IT design and innovation. These include *values in technical design* (Nissenbaum, 2005), *values at play* (Flanagan, Howe, & Nissenbaum, 2005), *worth-focused design* (Cockton, 2020), and *value sensitive design* (VSD; Friedman & Hendry 2019). Among these approaches, VSD is the most prominent as it already emerged in the 1990s and can look back on more than two decades of research (Winkler & Spiekermann, 2021). VSD has accumulated many qualitative learnings on the dynamics of individual values and their role in various case studies (e.g., Friedman, Kahn Jr., & Borning, 2006; Helbing et al., 2021; van Wynsberghe, 2013) along with a set of methods for stakeholder identification, value elicitation, and value analysis (see Friedman, Hendry, & Borning, 2017 for an overview). However, VSD's claim that the uncovered values support *ethical* design has been challenged by the criticism that VSD approaches are not systematically grounded in moral philosophy and need a higher commitment to ethics (Jacobs & Huldtgren, 2021; Manders-Huits, 2011; Reijers & Gordijn, 2019). This criticism is significant, as the moral foundation of values is the core feature that distinguishes values from needs (Fuchs, 2020), the core concept of approaches such as *human-centred design* (Norman, 2013) or *design thinking* (Brown, 2009). Unlike other concepts, values constitute ethical principles of the *ought-to-be* (Hartmann, 1932), that is, they "distinguish that which should be, as opposed to that which is" (Shilton, 2018, p. 128). However, without a proper ethical framing, values that are empirically identified in a technology design context might merely represent individual preferences (Reijers & Gordijn, 2019).

In this thesis, I address the claim that an ethically grounded conception of values requires the integration of ethical theory and analysis (Manders-Huits, 2011). In an empirical study where information systems students analysed three technology products and services, I investigate a value-based approach to technology design that elicits values from different ethical perspectives. Based on my findings, I argue that normative theories from ethics can provide an ethical grounding for the value elicitation process and that the combined perspectives of different theories of ethics can serve as a pluralist ethical framework for values (Bednar & Spiekermann, 2022). What is more, the empirical results suggest that an ethics-based approach focusing on values fosters creative thinking in the IT innovation process and can inform the decision-making process aiming at the decision for or against investing in a specific technology product. The study I present has accompanied the development of the recently published *Value-based Engineering* approach (VBE; Spiekermann, 2023; Spiekermann et al., 2022; Spiekermann & Winkler, 2020) and has informed the related IEEE 7000™ (IEEE Computer Society, 2021) and ISO/IEC/IEEE 24748-7000 "Standard Model Process for Addressing Ethical Concerns During System Design" (ISO, 2022). Thus, it has contributed to important developments that try to integrate an ethical perspective into standard procedures of system design and development.

The following sections review literature that motivate the consideration of values in technology design (Section 1.1) and identify gaps in research on how value-oriented technology design can be provided with the necessary ethical grounding (Section 1.2), from which I derive my three main research questions, 1) "How do the perspectives of different ethical theories influence value-based thinking in technology design?", 2) "How do ideas generated by a value-based approach compare to ideas captured in traditional technology Roadmapping?" and 3) "How does value-based thinking influence IT investment decisions?". In Section 1.3, I delineate my research aims and scope. I conclude this first chapter with a description of the structure of this thesis in Section 1.4 and an overview of related publications in Section 1.5.

1.1 Motivation for Considering Values in Technology Design

In the following sections, I review empirical studies on negative effects of IT use and related values as a motivation for considering values in technology design (Section 1.1.1). I then look into who is to be held responsible for a technology's impact (Section 1.1.2) and argue that no individual can carry the responsibility on her own, neither in technology development nor in technology use. A promising alternative to offloading responsibility on to individuals with specific roles is a methodological approach that aims at protecting and fostering values throughout the design process (Section 1.1.3). However, methods that have been proposed for a value-oriented design process have been criticized for lacking an ethical foundation. Few theoretical and empirical works have tried to provide solutions to this problem, a gap in research that I address in my thesis.

1.1.1. Reported Negative Effects and Related Values

A great number of studies reported various negative effects of using information and communication technologies (ICTs) such as the internet (Błachnio, Przepiórka, & Pantic, 2015; Caplan, 2003; Kuss, Griffiths, & Binder, 2013; Yao & Zhong, 2014), social media (Barkhordari & Willemyns, 2016; Brooks, 2015; Reid & Boyer, 2013; Salehan & Negahban, 2013) and cell or smartphones (Elhai et al., 2016; Lepp, Li, Barkley, & Salehi-Esfahani, 2015; Li et al., 2015; Salehan & Negahban, 2013; Twenge, Martin, & Campbell, 2018). Empirical results have reported poor sleep quality, decreased performance in work and school, reduced subjective well-being as well as psychological symptoms such as anxiety and depression (Alonzo, Hussain, Stranges, & Anderson, 2021; Elhai, Levine, Dvorak, & Hall, 2016; Li, Lepp, & Barkley, 2015). These symptoms are often caused by a lack of control over using new technologies or media (Li, Lepp, & Barkley, 2015) and imply a negative impact on both individual (e.g., health and well-being) as well as economic values (e.g., performance).

Another value that has received increasing attention is privacy. Studies in the United States (Pew Research Center, 2014) and Europe (TNS Opinion & Social, 2015) have revealed that people fear to lose control over their personal data as third party companies or the government access their personal information and millions of records have been exposed in major privacy breaches (Verizon, 2017). Other concerns have targeted ethical issues related to the decisions of algorithms[1] or hate speech on social media platforms (e.g., Mondal, Silva, & Benevenuto, 2017) and how to deal with the implied infringement of values such as equality, freedom, and fairness. The Cambridge Analytica scandal triggered discussions on the power of digital monopolies and the dangerous impact of social media platforms on the values of a democracy.

A recent taxonomy (Gimpel & Schmied, 2019) demonstrates that risks and side effects of digital technologies and media range from the individual level to society at large: Individuals are confronted with negative psychological effects such as technostress, while at the interpersonal level, cyberbullying takes place; system malfunction affects organizations and their operations, and the market power of quasi-monopolies leads to inequalities at the inter-

[1] See, for example, https://cihr.eu/eoa2015web/

organizational level; at the highest level, hate speech and an AI singularity instigate public discourses on adverse effects for society and economy at large.

Together, these developments and empirical studies raise concerns about human values in a digital world such as psychological and physiological wellbeing, privacy, autonomy, and integrity, as they are rarely the concern of the companies that develop technological products. In their current form and use, many information technologies are not sustainable for individuals and societies nor bring success to companies when reported adverse effects damage the company's reputation, as has happened in the VW emission and Cambridge Analytica scandals. Still, the pressure building with the increasing number of empirical findings that report negative effects does not indicate where the responsibility lies, which makes it difficult to steer developments into the right direction.

1.1.2. Locating the Responsibility

Arguments could be made that it is the user who is responsible for his or her own technology use, or the company that sells the respective technological product. Engineering associations such as the ACM (2020) emphasize the responsibility of the engineers, that is, the people developing the technological system. In the following, I present empirical findings reported in the literature as well as my own findings from two qualitative studies (Bednar & Spiekermann, 2018; Bednar, Spiekermann, & Langheinrich, 2019) to emphasize that neither the users nor the engineers are capable of dealing with the challenges that new technologies confront them with. Based on these findings, I argue that only a methodological approach that considers ethical implications of a technology at an early stage of the innovation process can lead to an ethically aligned and thus sustainable technology design.

People increasingly use technologies, devices and applications that have also been associated with a negative impact on values associated with human well-being and performance. In 2021, 87 percent of the population older than 15 years possessed a smartphone, the most wide-spread device to access the internet (Turulski, 2022). The complexity of human behaviour has led to a plethora of scientific concepts that try to describe the underlying mechanisms of social media use (see Ngai, Tao, & Moon, 2015 for an overview) and no theory has been agreed on that can explain why people keep using the internet despite its negative effects (Kardefelt-Winther, 2014). In my own research (Bednar & Spiekermann, 2018), I looked into why users do not take action to counter negative effects, that is, protect important values that are negatively impacted by their own use of technologies. Results of 12 in-depth interviews showed that undergraduate students, who represent typical ICT users, predominantly associated ICTs with value benefits such as convenience, efficiency, information and communication with loved ones. At the same time, every benefit came with a downside that was typically mentioned only at a later point in the interviews, e.g., the need to be reachable all of the time, social pressure, and constant distraction. When asked what they would change, the participants reflected on their own behaviour, but felt incapable of changing habits such as taking their laptop to bed, pointing to a loss of control and autonomy ("What I'm noticing with myself and with my friends is that ... we cannot control it—that is the problem", p. 211). Instead, they came up with very strict measures such as a minimum age for using the internet or smartphones (ranging from 10 to 16 years) or even technical measures to enforce internet-free days or time periods at the state level.

The behavioural patterns and experiences discovered in the interviews (Bednar & Spiekermann, 2018) clearly indicate that young ICT users do not feel in control of their own use of ICTs, despite being aware of several problematic effects of information technology on important values such as control and autonomy. While the term "addiction" is disputed in this context and there is no general understanding of where the border lies between healthy and problematic ICT use (Billieux, Maurage, Lopez-Fernandez, Kuss, & Griffiths, 2015; Davis, 2001; Kardefelt-Winther, 2014), several of the reported experiences such as a lot of time spent online, isolation from friends, a sense of guilt and a perceived loss of control have been considered typical symptoms of internet addiction (Davis, 2001; Kardefelt-Winther, 2014). From this, I conclude that individual users are overwhelmed with the responsibility to control the impact of ICT use on their own behaviour and well-being, let alone social and societal effects. Instead, users seem to rely on legislation to handle negative effects once technological products are in use. But with many emerging technologies, the consequences cannot be estimated beforehand and it takes time for legal measures to come into effect. Thus, potential negative effects need to be taken into account in the development phase of new technological products, when specific values can still influence design choices *before* products are launched.

This shifts the attention to those who develop technical devices and applications: systems engineers. However, when it comes to the study of engineers' use of ethics-based design practices, the literature is inconsistent. For example, it is not clear whether the organizational environment impedes engineers to behave in line with ethical conduct (Berenbach & Broy, 2009), or can support ethical conduct, as Szekely (2011) found for a group of IT professionals. A similar inconsistency can be observed for the subjective attitudes of systems engineers towards considering privacy as an exemplary value that is highly relevant for information technologies. Langheinrich and Lahlou (2003) reported that engineers were "not feeling morally responsible" (p. 5) and lacked expertise and time to deal with privacy issues whereas more recent research found that an "ethic of care" (p. 8) for users makes app developers consider privacy measures (Greene & Shilton, 2018). In my own research based on transcripts of interviews that my supervisor Sarah Spiekermann had conducted with several senior systems engineers of known IT companies, I approached this inconsistency and wanted to find out whether there has been a shift to a more ethically oriented attitude amongst systems engineers.

Results of our qualitative analyses of engineers' motivation to take information privacy into account in their system development projects (reported in detail in Bednar, Spiekermann, & Langheinrich, 2019) showed that the interviewed engineers expressed a negative, sceptical, or pessimistic view of information privacy in more than three quarters of all 243 comments on privacy, associating the implementation of privacy with various problems and difficulties. Engineers expressed that they did not see privacy as an absolute value as it has "room for interpretation" (p. 130) and emphasized its context-dependency, which is in line with Nissenbaum's (2009) work on *contextual integrity*. Also, they experienced privacy as difficult to operationalize, e.g., because they think that customers can be manipulated. Furthermore, engineers saw an unclear legal basis of privacy and believed that privacy only makes sense once the "legal issues have been 'fixed'", stating that "without a legal framework there is no chance of getting privacy" (Bednar, Spiekermann, & Langheinrich, 2019, p. 133). EU's General Data Protection Regulation (GDPR; The European Parliament and the Council of the European Union, 2016) may have contributed to a better legal understanding of privacy since it came into effect in May 2018. Still, systems engineers expressed limited, conflicting or *no* perceived responsibility ("my part is a really small one in that scale"; "it is really up to them") in our study (Bednar, Spiekermann, & Langheinrich, 2019, p. 136). What is more, they reported to not have full autonomy or control to develop privacy protection mechanisms, which is due partly to a lack of resources and time to deal with privacy issues, and partly to a lack of skills to deal with technical challenges ("the design itself is very hard", p. 134).

Overall, our findings showed a surprisingly low motivation of systems engineers to implement privacy protection measures technically (Bednar, Spiekermann, & Langheinrich, 2019). The related quantitative study further emphasized that organizations need to provide their engineers with more time, autonomy, and appropriate ethical norms to deal with values such as privacy (Spiekermann, Korunovska, & Langheinrich, 2018). However, taking over responsibility is not simply a practical matter—it is also a moral issue, and one that we need to take seriously especially in the context of technological developments (Jonas, 1984). To tackle it, Shilton (2013) has argued that we need new practices to support the design and development of systems in accordance with important values. Such *values levers* (Shilton, 2013) would strengthen ethical practices that engineers need as guidance instead of half-heartedly complying with the ethical codes that organisations advocate internally (Consoli, 2008).

1.1.3. Considering Values in Technology Design

I have argued above that both the users and systems engineers are overwhelmed with carrying the responsibility for how a technology's impact plays out at the individual, social and societal level on their own. If we want better technology, we need to find a way to navigate through the technology design process guided by a concept of what is good and right, so that the impact of the resulting IT products and services is not completely dependent on its users and their behaviours. Innovation teams and engineers are confronted with the need to not only provide technical or economic value to traditional stakeholders, but to foster human, social and environmental value for a sustainable development of markets and society (Freudenreich, Lüdeke-Freund, & Schaltegger, 2020; Penzenstadler & Femmer, 2013).

The European Commission Directorate-General for Research and Innovation (2013) has called for the responsible design and development of new (technological) products and services based on an evaluation of ethical values such as well-being, justice, and equality, among others. In this context, the concept of values moves away from the classic economic understanding of benefits opposed to costs or the basic functionality that a product or service offers to customers. Such notions lack moral import and embrace a very narrow view on potential value benefits and harms. In contrast to this, values can be used to represent morally relevant principles and ideas that go far beyond functionality, i.e., in the form of "supra-functional requirements" (van den Hoven, 2017, p. 70). Ideally, meanings of "value" are seen at the juxtaposition of the social, economic and technical domain (Nicolescu, Huth, Radanliev, & De Roure, 2018) and sustained for technological products and services throughout their lifecycle (Nicolescu et al., 2018).

Several disciplines and areas of research deal with the design, management, and use of information technology. Among these are information systems, innovation management, and design science and research. While they all focus on finding solutions to problems, there is no common approach to addressing ethical issues and implications. Innovation management typically considers risks and there is a volume of information systems research on specific ethical principles such as privacy, but ethical aspects are rarely addressed in a more general form (Stahl et al., 2014). In recent years, almost 100 private and public organizations as well as research institutions have tried to demonstrate their ethical engagement by publishing lists of value principles that employees, developers, designers, etc. should adhere to (Jobin et al., 2019). These lists promote an organization's commitment to protect values such as privacy, transparency, absence from algorithmic bias, etc. However, the moral foundation of pre-defined value lists has been questioned (Mittelstadt, 2019).

It is doubtful whether predefined value sets can represent the wide range of ethical implications a technology might have. When pre-configured value lists are used in the field of human-computer interaction (HCI), they project values onto empirical cases by applying the logic of the list to the problem at hand (Le Dantec et al., 2009). This inadvertently leads to a limited view on the value spectrum affected by a technology. To avoid these limitations, scholars have argued for a bottom-up elicitation of values that takes the context of the respective technology into account (Le Dantec et al., 2009; Reijers & Gordijn, 2019). Thinking about a technology's impact early in the development process can result in ethical recommendations for morally more desirable IT products and uses (Brey, 2012) and provide a safeguard against inflated expectations followed by disillusionment, as observed with hypes (Linden & Fenn, 2003).

VSD has been referred to as a guided innovation approach that supports engineers in fulfilling their responsibility to reshape the world by incorporating moral values into technology design (Jeroen van den Hoven, Lokhorst, & van de Poel, 2012). VSD has been applied for many different domains and key technologies ever since with the use of a variety of methods (Friedman et al., 2017). However, the claim that values being uncovered supports *ethical* design has been criticized for its vagueness and lack of a proper ethical foundation (Manders-Huits, 2011; Reijers & Gordijn, 2019). A value-oriented approach that is not thoroughly grounded in ethics might unveil values that are not "higher" in an ethical sense. Critics have therefore argued that value-oriented approaches lack an ethical foundation (Jacobs & Huldtgren, 2021; Manders-Huits, 2011) and that only proper ethical reflection can ensure that the value elicitation process identifies values of moral relevance and not just arbitrary stakeholder preferences (Reijers & Gordijn, 2019). As I will show in the following, this forms an important gap in existing research and methodology that has inspired the main research questions of this thesis. What is more, it has influenced the further development of value-based design (Spiekermann, 2016) into what has become VBE (Spiekermann, 2023).

1.2 Research Gap: An Ethical Framework for Value-based Idea Generation and Evaluation

While much can be learned from existing literature on ethical technology design, some fundamental issues persist. How can we create technology that is ethically justified? In its core, ethical design brings together two concepts that are normally not associated: design is about the *act* of *creating*, while ethics is about *justifying acts*. Thus, one problem is how the use of a specific method or the resulting artefact can be justified in the technology design process. Stolterman (2008) has argued that “high-level theoretical and/or philosophical ideas and approaches that expand design thinking but do not prescribe design action” (p. 63) can support design practices by reducing the complexity in design situations while at the same time supporting reflective practice and decision-making. In this thesis, I show that ethics can well complement design approaches and does not constrain the technology design process, but opens up creative design space. In the following, I derive three main research questions on a more ethically aligned technology design and innovation process from previous research. With the first research question (RQ1, Section 1.2.1), I investigate whether normative theories of ethics could provide an ethical framework for values. I derive two additional research questions from the gap in existing literature and research on how a value-based approach plays out in traditional innovation processes.

Typically, the focus of innovation lies on creating new products and services that can be successfully brought to the market. Designing artefacts related to information systems forms its own area called *design science* (e.g., Offermann, Blom, Bub, & Levina, 2010). With it, both the scientific approach and the design approach have an important place in the information systems discipline (Hevner, March, Park, & Ram, 2004). Still, the *conceptualization* and *generation* of an innovation are rarely studied from a general information systems perspective (Jha & Bose, 2016), where the adoption and diffusion of innovations is much more often the focus of research (Xiao et al., 2013). This might be due to the fact that design is focused on finding solutions to a problem (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007), a creative process that is often considered opposed to (social-)scientific methods and paradigms employed in information systems (Stahl et al., 2014). However, the aim of an ethically aligned technology system needs both an adequate description of the problem *and* creative solutions that will be adopted by the respective users and stakeholders. Against this background, it seems worthwhile to investigate how values play out in two key areas of creativity that also play an important role in the innovation process: idea generation and idea evaluation (Puccio & Cabra, 2012). In order to investigate ideas generated in the innovation process, RQ2 (Section 1.2.2) looks into how a value-based approach can complement technology roadmapping, a traditional approach that guides the IT innovation process from the generation of ideas onwards. To explore the influence of values on idea evaluation, RQ 3 (Section 1.2.3) investigates how individuals weigh value ideas when deciding on whether the technological product under consideration is worthy of an investment.

1.2.1. An Ethical Framework for Values

Current accounts of values in technological design and innovation need an ethical theory "that can reflect on moral arguments and considerations" (Taebi, Correljé, Cuppen, Dignum, & Pesch, 2014, p. 122). However, top-down approaches of classical ethical theories such as utilitarianism and deontology apply general principles or rules to particular cases (Jacobs & Huldtgren, 2021). The high degree of universality that they aim at cannot only be seen as a strength: A *mere* theory-driven approach is too strict to guide the design of a technology based on moral claims (Umbrello, 2020b). At the same time, a purely bottom-up, casuistic approach that focuses only on particular cases lacks moral justification, i.e., needs "a recognized and morally relevant norm" to "connect the cases" (Jacobs & Huldtgren, 2021, p. 24). What we are looking for then is a framework that combines the bottom-up perspective that takes the specific aspects of a particular situation, i.e., a particular technology and affected stakeholders, into account, with a top-down perspective, i.e., a theory that provides the moral foundation beyond the specific aspects of the particular case. The question is: which theory to choose?

Many empirical studies of ethical decision-making have studied deontology and utilitarianism as underlying ethical theories, whereas virtue ethics has been included only rarely (Drašček, Rejc Buhovac, & Mesner Andolšek, 2020). More importantly, the respective studies did not focus on technology design. Only few studies have investigated how a specific ethical theory plays out in the discovery of relevant values. Noteworthy in this regard is van Wynsberghe's (2013) proposal of a "care centered value sensitive design methodology" (p. 424), a framework for the retrospective and prospective ethical evaluation of care robots and their design. Van Wynsberghe (2013) addresses the issue of the lacking normative grounding of VSD by focusing on values in the conceptual investigation that have been previously identified as the fundamental moral elements in care practices: attentiveness, responsibility, competence and reciprocity. In contrast, Boenink and Kudina (2020) stress that "values manifest themselves in our ways of doing" (p. 7) and thus argue for a practice-based approach to values rooted in pragmatism. They propose hermeneutic methods that focus on the valuing process for the identification of relevant values of a new technology rather than pre-set value lists or values mentioned by stakeholders. Reijers and Gordijn (2019) also emphasize the importance of practices, but argue for a *virtuous practice design*, as virtues, other than values, are grounded in a normative theory and go beyond the design of a technology by also supporting practices such as education and training. The value-based design and engineering methodology by Spiekermann (2016, 2023; see also Spiekermann & Winkler, 2020) presents a different solution to this problem. The aim of the value-based approach is to identify values from the ethical viewpoints of different ethical theories such as utilitarianism, deontology, and virtue ethics and provide guidance for how the identified values can be considered throughout the design and development process as ethical system requirements.

These cases provide first theoretical arguments and empirical insights on selected ethical frameworks. However, to my knowledge, no empirical research has yet compared different ethical perspectives, let alone their contributions to a value-oriented technology design and innovation process. There is a gap in empirical research comparing how ethical theories play out in practical settings in general and in the context of values and design specifically. This leads to my first research question (RQ1).

- **RQ1: How do perspectives of different ethical theories influence value-based thinking in technology design?**

In this thesis, I address this gap in research by investigating the unique contributions of three theories of ethics to the generation of ideas that relate to values in technology design and investment decisions. Utilitarianism, deontology and virtue ethics can be considered the "big three" theories of ethics in the Western world (Stahl et al., 2014). It is important to note that they differ significantly in the way they derive what is good and right and thus, as normative ethical theories, are in competition. And still, in this thesis I argue that the combined application of the three theories' core concepts in a concrete design setting such as the value elicitation process has the potential to identify complementary ethical aspects.

It has been argued before that top-down ethical approaches such as utilitarianism and deontology can complement each other in a practical setting, e.g., through a framework that follows rules but makes exceptions where reasonable in a business context (Brady & Dunn, 1995). Yet, because of their unique ethical reasoning, utilitarianism, deontology, and virtue ethics are known as rivalling theories (Kagan, 2018), exhibiting different advantages and problems from a philosophical view. What is more, whether virtue ethics can and should be mentioned as a normative theory alongside deontology and utilitarianism is controversial because of its fundamentally different conception of what constitutes a good action and a good life (see, e.g., Brewer, 2009). Thus, I want to emphasize that in this thesis I move away from a theoretical discussion of ethics and apply the core reasoning of each theory in a pragmatic manner in order to inspire the elicitation of values when analysing a specific technology context. The aim of such an "ethical analysis" is not to assess whether an act is right or to identify the best option from a moral perspective, still less to show the superiority of one theory over another. Rather, it should provide an additional level of ethical reflection for the value elicitation process (Reijers & Gordijn, 2019). Applying a concrete ethical perspective could support those involved in technology design in entering the *philosophical mode* (Flanagan, Howe, & Nissenbaum, 2008), that is, "to address questions about the origin and scope of relevant values, their conceptual meaning, and the basis of their prescriptive force" (p. 325).

One could argue that choosing one normative theory as ethical framework would be the better solution. However, contemporary moral thinking might be more susceptible to the combination of different ethical concepts. MacIntyre (1981/2007) has argued that the language of morality in our world makes use of "fragments of a conceptual scheme, parts which now lack those contexts from which their significance derived" (p. 2). This lack of (historical) context explains the use of rival arguments and their conceptually incommensurable premises in contemporary moral debates (MacIntyre, 1981/2007). It also explains why people use different ethical theories in different circumstances, as has been observed for managers in the business versus private context (Drašček et al., 2020). From a philosophical standpoint, this is a "moral calamity" (MacIntyre, 1981/2007, p. xvii), but from a practical view, this kind of moral pluralism supports the deliberate combination of different ethical concepts. If the core concepts of utilitarianism, deontology, and virtue ethics are implicitly available in our contemporary moral thinking, they could complement each other in the elicitation of values to produce a more holistic value perspective on a specific technology. Precisely because they propose different perspectives on good action and good aspects of human character and behaviour, the unique approaches of utilitarianism, deontology and virtue ethics could inspire different ideas on how human values are impacted by a technology. For example, utilitarianism, which focuses on utility created through an actions' consequences, could inspire ideas that focus on the product's consequences for affected stakeholders. Deontology, with its focus on moral obligations, could complement this perspective by strengthening the designer's personal moral reasoning and her perceived duties. Virtue ethics could help to identify an information system's impact on morally desirable character traits of the persons affected by it by recognizing whether it fosters virtues, undermines virtues or even supports the development of vices. When identifying and anticipating the potential impact of a technology through such a pluralist ethical analysis, values can provide a common level to crystallize and represent identified ethical issues and potentials.

There is no general agreement in the literature how principles and ideas captured by values can be evaluated. In order to compare differences in value ideas elicited through the different ethical perspectives, I seek to connect the concept of values to the currently widely discussed concept of sustainability, as has been suggested by Winkler and Spiekermann (2019), and make use of the differentiation between instrumental and intrinsic values as defined, e.g., by van de Poel and Kroes (2014). Here, it is of interest to find out whether different ethical perspectives inspire value ideas with moral import and to explore whether differences in elicited value ideas can be explained by the unique ethical reasoning of the respective theory.

1.2.2. Value-based Idea Generation and Technology Roadmapping

Technology roadmaps focus on aligning technology to product and service developments, business strategy, and market opportunities (Phaal et al., 2004). Roadmapping serves as comparative baseline in this thesis because daily innovation planning practices still centre around technology roadmaps (de Alcantara & Martens, 2019; Vinayavekhin et al., 2021), which form the joint focus for teams involved in IT innovation planning in many companies. What is more, technology roadmapping has been studied extensively with an increase in the number of publications over the years (de Alcantara & Martens, 2019) and has been extended to deal with current challenges (Munch, Trieflinger, & Lang, 2019; O'Sullivan, Phaal, & Featherston, 2021), whereas research efforts on novel approaches such as design thinking have been outpaced by practice and training (Puccio & Cabra, 2012).

Dissel, Phaal, Farrukh, & Probert (2009) have even presented *value roadmapping* as "a framework for supporting technology evaluation and valuation (to explore, communicate, calculate, maximize and manage value)", which includes "the early stages of a technology development project to explore the value proposition and to improve the design of the technology development project (risk reduction)" (p. 47). However, they understand value only in terms of revenues and savings and not in terms of a pluralist, morally grounded concept that represents ideas of the good and right. Here, the question arises whether a value-based approach could complement traditional technology roadmapping by supporting the identification of an additional set of ideas that relate to ethically grounded values for the roadmap. This leads to my second research question (RQ2).

- **RQ2: How do ideas generated by an value-based approach compare to ideas captured in traditional technology roadmapping?**

Managers are required to create an environment that not only stimulates creativity (Rose, Jones, & Furneaux, 2016), but also supports the consideration of ethical implications and values. In the past, it has sometimes been argued that a concern for values such as privacy would undermine the innovativeness of the economy (e.g., Holden, 2020). However, creativity and ethics can go hand in hand when the apparent constraints of an ethical perspective or the concept of values help to uncover creative ways of designing technology for human welfare (Shilton, 2013; Jeroen van den Hoven et al., 2012). In line with this, Wallach and Vallor (2020) define creative moral reasoning as "the ability to invent new and appropriate moral solutions in ways underdetermined by the past" (p. 392). The ethical *forecasting* involved in the value identification phase allows to consider many potential ethical issues that a technology could bring about (Brey, 2012), which not only increases ethical sensitivity, but also supports creative thinking. To my knowledge, no study has yet tested the creativity potential of an ethics-based value approach for information system design.

To account for the importance of creativity in design and innovation, I assess value ideas in terms of three creativity parameters, i.e., fluency, flexibility, and originality. These parameters originate from J. P. Guilford (1966, 1971), who conceptualized creativity as a person's divergent-production ability, that is, the ability to generate many new solutions to a problem. Typically, this is tested as the ability to come up with multiple responses in an open task, or in the present study, the number of ideas generated. Generally, there are good arguments for considering other aspects than quantity when evaluating generated ideas, and quality, novelty, and creativity are among the most commonly used constructs (Dean, Hender, Rodgers, & Santanen, 2006). However, I focus on *value ideas*, that is, ideas that relate to or represent a value, and every value idea is potentially relevant for the subsequent steps of the innovation process. This is because the ethical framework I apply for the value identification phase justifies an understanding of values as representing what people appreciate as good and right in form of principles and ideas (see Section 2.2.3 "Values Have Moral Import"). Thus, the number of value ideas in terms of *fluency* represents a relevant and objective first indicator for creative value thinking. The other two creativity parameters provide additional parameters for the quality of the value ideas when the *flexibility* of value ideas is understood in terms of covered sustainability dimensions (Penzenstadler & Femmer, 2013; Winkler & Spiekermann, 2019) and *originality* in terms of rare ideas as opposed to mainstream values (Spiekermann, 2016), addressing important aspects for value-oriented design discussed above.

1.2.3. Value-based Idea Evaluation and Decision-Making

Taking an ethical stance in the innovation process should not be limited to the generation of ethically aligned design ideas. IT design and innovation is about coming up with (new) products and services that will be implemented and used widely (Martins & Terblanche, 2003), and it is especially the wider impact that a technology has once it is in use that bears moral relevance (Moor, 2005). Some products, e.g., Google Glass, did not even make it into that stage because of pressing ethical issues that were not considered during the product design phase but came up soon after the product was launched. Dissel et al. (2009) emphasize the potential of early-stage technology valuation based on a technology roadmap as “recognizing value in threats and opportunities arising from future events and incorporating flexibility into managerial action in response to them are essential” (p. 46). Thus, the consideration of a technology’s impact should affect management’s decision-making when deciding whether it should be developed in the first place, especially since “technology projects typically require sequential investments” (Dissel et al., 2009, p. 46). Here, it would be of interest to see how the concept of values changes the evaluation of ideas in investment decision-making.

With my third research question, I go beyond the elicitation of relevant values and explore how the unique ethical perspectives affect important decisions in the IT innovation process. Manders-Huits (2011) has argued that the priority of values should be judged based on ethical theory and analysis. Ethical theories define rules and concepts that should help us in guiding our actions and behaviours. Thus, it seems relevant to explore whether an ethics-based technology design process with a value focus makes a difference when it comes to decisions made with regard to the actual design of an IT product. However, the influence of a specific ethical view on an individual’s overall evaluation of a technological product and related values has not been in the focus of research. From this, I derive the following research question (RQ3).

- **RQ3: How does value-based thinking influence IT investment decisions?**

I want to close this gap by exploring literature on traditional and value-based decision-making strategies and investigating empirical data on value-based investment decisions from different ethical perspectives. In this thesis, I follow the aim that Dissel et al. (2009) map out for their value roadmapping approach: to investigate how a value-based approach affects the next phases of the innovation process, especially the critical stage where management evaluates the proposed product or service design and chooses the direction it wants to take. However, I complement the project of Dissel et al. (2009) with a pluralist and ethically grounded understanding of values.

Dissel et al. (2009) emphasize that a quantitative evaluation of early-stage technologies is difficult because of the high levels of uncertainty and that decisions are often made based on a gut feeling. To answer RQ3, I will look into patterns of individuals' decisions and investigate whether they take values into consideration based on a quantitative evaluation of net value effects (described in Section 3.5.3) and a qualitative evaluation of the reason they provided (described in Section 3.5.4). The process of evaluating values in investment decisions could be similar to the ways in which individuals solve value conflicts (de Graaf, 2021; Friedman et al., 2017; Hulstijn & Burgemeestre, 2015; Miller, Friedman, Jancke, & Gill, 2007) or rank values (van de Kaa, Rezaei, Taebi, van de Poel, & Kizhakenath, 2020), which have been widely researched. They could also rely on risk-benefit evaluations (Jobin et al., 2019) or (implicitly or explicitly) emphasize particular values (Hulstijn & Burgemeestre, 2015).

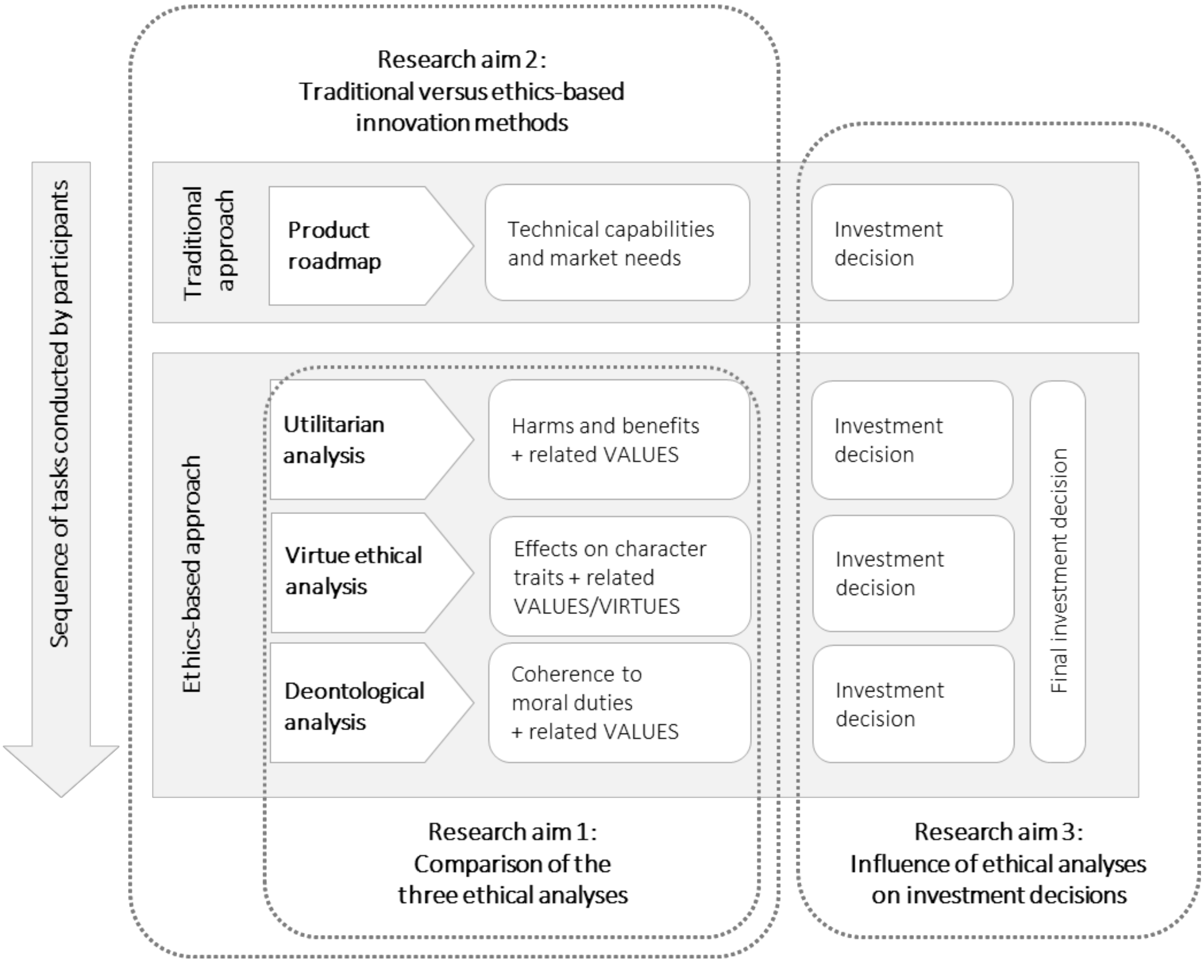
1.3 Research Aims and Scope

In the following, I first provide an overview of the three main research questions in Section 1.3.1. I further confine the research aims of this thesis in Section 1.3.2.

1.3.1. Overview of Research Questions

To address the identified gaps in research, I empirically investigate a value-based approach that combines top-down ethical perspectives with the bottom-up elicitation of values for a specific technology context at an early stage of the innovation process. I am interested in the unique contributions of three different theories of ethics (RQ1) as well as how the joint output from such an ethics-based generation of value ideas can complement technology roadmapping (RQ2) and investment decision-making (RQ3). Figure 1 provides an overview on the research aims and presents the tasks the participants conducted in the empirical study.

Figure 1. Research aims and tasks tested in empirical study of this thesis



1.3.2. Aims and Scope

With this thesis, I want to provide new and original insights that can help to advance the value-oriented technology paradigm. Based on three different technological products, I look into whether value elicitation with the help of philosophical perspectives can identify values that go beyond mainstream values by acknowledging the specific context, pertain to higher ethical principles (i.e., intrinsic values and virtues), and support a broad spectrum of sustainability dimensions (e.g., individual, social, environmental, etc.). The empirical study that I present is unique and novel in that it compares different ethical perspectives empirically and analyses the resulting value ideas based on their underlying sustainability dimensions and theory-driven specificity. With it, I aim to provide an empirical example for how a pragmatic approach to complex theoretical concepts of philosophy can enrich existing practices in information systems design and innovation as well as an empirically founded argument for combining ethical perspectives in practical settings. Most importantly, I want to show that values can help to bridge the gap between socio-ethical issues and technical requirements (Aizenberg & van den Hoven, 2020), between ethics and design (Cummings, 2006; Timmermans et al., 2011). Ethical theory, even when applied in a condensed version, can inspire a technology design that is sustainable from the perspectives of the individual and society. “Technology” or “information technology” as the object of investigation in this thesis refers to digital technologies or information (and communication) technologies, that is, devices and applications that process information. While the general merits of a value-based approach can most probably be applied to other technologies too, I focus on technologies that humans interact with.

While I discuss the limitations of the empirical study and its theoretical assumptions in detail further below (see Section 5.2 “Limitations and Future Research”), I briefly want to comment on the focus on the ideational phase of the product design and development process. In the empirical study that I present, participants came up with a list of ideas, but did not prioritize them, assess their feasibility, or implement them. In Section 2.5.4 “Traditional and Value-Based IT Innovation Strategies”, I briefly discuss how value conflicts and value prioritization could influence subsequent decision-making in the innovation process. Furthermore, I did not evaluate participants’ activities or their circumstances but focused on their output in terms of ideas related to the product that they analysed. The focus of this thesis is on this value *elicitation* or *discovery* phase. However, other value-oriented frameworks go beyond this scope. For example, concepts such as values levers (Shilton, 2013) and virtuous practice design (Reijers & Gordijn, 2019) put emphasis on those involved in developing a technology and how particular activities can support values in the technology’s design. What is more, VBE (Spiekermann, 2023) and the related IEEE 7000™ Standard (IEEE Computer Society, 2021; ISO, 2022) cover the entire design and development process down to system requirements where VBE even reflects on how a “value-based culture” (Spiekermann, 2023, p. 13) can be created within an organisation.

1.4 Structure of the Thesis

In the following, I briefly summarize the structure of the thesis. In the introduction, I have reviewed literature and developments that showed a negative impact of information technologies on individuals’ well-being as well as societal concerns associated with the widespread use of some technologies. Together with the reported systems engineers’ lack of motivation to consider ethical principles, these findings have pointed out a major gap in responsibility and control in the IT design and development process and the need for a dedicated design process that aims at a more ethically aligned design of technology.

In Chapter 2, I present the “Theoretical Background: Values in Technology”. In Section 2.1 “IT Innovation and Design”, I describe the multidisciplinary background of the thesis in more detail and define key concepts in (technology) innovation and design such as creativity and the inclusion of stakeholders. In Section 2.2 “The Concept of Values”, I delineate the concept of values and how it has been defined in different contexts. Subsequently, I present a summary of critical observations and issues related to the concept of values in practice in Section 2.3 “Value-oriented IT Approaches and Current Challenges”. This sets the stage in Section 2.4 for the discussion of “Candidates for Providing an Ethical Foundation” and the entry of three theories of ethics. I briefly describe the core reasoning of utilitarianism, deontology, and virtue ethics and formulate more specific research questions for their comparison. Finally, I describe technology roadmapping and investment decision-making as typical and traditional practices in IT innovation and formulate specific research questions on whether they could be complimented with a value-based approach in Section 2.5 “Bringing Values to IT Innovation Practices”.

Chapter 3 describes the method that the empirical study presented in this thesis is based on, including the detailed steps of coding the qualitative data and the resulting dependent variables that cover creativity measures, acknowledged stakeholders, and investment decision patterns.

In Chapter 4, I present the results for the three main research questions “How do the Perspectives of Different Ethical Theories Influence Value-based Thinking in Technology Design?” (Section 4.1), “How Do Ideas Generated by a Value-based Approach Compare to Ideas Captured in Traditional Technology Roadmapping?” (Section 4.2) and “How Does Value-Based Thinking Influence IT Investment Decisions?” (Section 4.3). As the research questions build upon each other, these subchapters do not only present detailed results of the empirical data but also include a brief conclusion.

In Chapter 5 “Discussion and Outlook”, I discuss implications for theory, practice and research (Section 5.1) as well as limitations of the study design and tested ethical approach (Section 5.2). In Section 5.3 “Outlook: Rethinking the Human-Technology Relation”, I take a look ahead and touch upon a paradigm shift that seems relevant for further developments in technology design and innovation. I delineate discourses of human nature and technology that question established dichotomies such as the traditional categories “human” and “technology” or “mind” and “body” and conclude with a call for a positive reconceptualization of both what it means to be human and the role of technology.

The most important points resulting from the empirical findings and their interpretation within the wider research context are taken up again in the final chapter of this thesis. Chapter 6 “Conclusions” provides a synopsis of the three research questions, the respective empirical findings and their implications in three sections on “Values as a Bridge Between Technology Ethics and Design” (Section 6.1), “A Pluralist Ethical Framework for Value Elicitation” (Section 6.2), and “Increased Creativity and Biased Thinking in Traditional IT Innovation” (Section 6.3).

1.5 Related Publications

Throughout my time as PhD candidate, I have actively participated in academic conferences and have published the results of my research in conference proceedings and journals. Appendix A “Author Publications” shows relevant publications that are based on the empirical work presented in this thesis, which I briefly describe in the following.

I have presented results of my qualitative analysis of how new technologies affect young adults’ at the *13th Human Choice and Computers Conference* (HCC13; Bednar & Spiekermann, 2018) as a core motivation to look deeper into the design of information technologies and the various ways in which they affect users and other stakeholders. The qualitative insights that I reached through the analysis of interviews with senior information systems engineers was published in *The Information Society* journal (Bednar et al., 2019), showing that engineers did not feel in control of protecting important values such as privacy and security in the systems that they built, and did not perceive themselves as responsible.

In 2020, I presented first empirical insights at the *Ethicomp* conference (Bednar & Spiekermann, 2020), comparing the perspectives of utilitarianism, deontology, and virtue ethics on the (re-)design of three technologies. The detailed results on the unique perspective that each theory of ethics contributes to the identification of relevant values in the technology design process (RQ1) presented in Section 4.1 of this thesis have been published in the *Science, Technology, & Human Values* journal online (Bednar & Spiekermann, 2022).

Together with my PhD supervisor, we have submitted detailed findings on the comparison of the ethics-based value elicitation method with traditional technology roadmapping (RQ2) to the *Business & Information Systems Engineering* journal (latest decision: “Accept (with minor revisions)", May 11th, 2023). Parts of this manuscript appear in Section 4.2 of this thesis. The empirical investigation of how the value-based design process affects investment decisions (RQ3) has not been published yet.

Finally, the outlook on potential paradigmatic shifts in the field presented in Section 5.3 is based on a conference paper (Bednar, 2020) that was included in the proceedings of the *14th IFIP TC9 International Conference on Human Choice and Computers (HCC14)*.

2 Theoretical Background: Values in Technology

For thousands of years, people have thought about what it means to do the right thing and how to come to a justified judgment in this matter. Over time, different theories of ethics have been established and the philosophical discourse on each theory's benefits, challenges, and possible solutions is ongoing. Recently, both theoretical works and practical approaches have tried to address current ethical challenges with related to the use and design of technology (e.g., Brey 2015; Friedman et al. 2006; Vallor 2016). Against this background, one could assume that projects in research and industry apply insights from computer ethics to the information systems that they use and develop. However, while many important *topics* of computer ethics, e.g., privacy and intellectual property, are addressed, ethical *theory* does not play a big part in the discipline of information systems (Stahl et al., 2014).

At the same time, technology design and innovation have seen the development of several alternative concepts and methods that try to move things into a better direction. Considering the question of how human values can be supported through a technology's design is an especially promising approach that tries to promote new and ethically sound IT products and services. It is not surprising, then, that developments in ethics and IT have converged in the focus on values:

> Ethics has developed from fully theory-oriented through application and context awareness to a focus on the process of designing; similarly IT has gone from being solely technology driven through context awareness to value sensitivity. As a consequence, a current and notable relation between ethics and IT is the focus on values in the design process. (Albrechtslund, 2007, p. 65)

And still, the concept of values in terms of morally relevant principles and ideas has not fully arrived in current IT innovation practices. In this thesis, I aim to explore different approaches that could support value-based thinking in the IT innovation process.

In the following sections, I review the literature on current challenges in the fields of design and innovation. I start with a brief overview on important developments and concepts in innovation and design in Section 2.1 to establish a theoretical and historical basis. Some developments have led to what I focus on in my thesis: methods that aim at value-driven, socially responsible and thus ethically oriented information technology. As values form the core concept of this thesis, I discuss the conceptualization of values and its challenges in more detail in Section 2.2. After reviewing problems of both top-down and bottom-up approaches to values in technology design (Section 2.3), I discuss how ethical theories could complement the generation of value ideas to meet these challenges (Section 2.4) and inform traditional innovation approaches (Section 2.5).

In the empirical part of this thesis, I compare a traditional IT innovation approach with an ethics-based value approach. I investigate their influence on the generation and evaluation of ideas and decisions that are based on these ideas by analysing empirical data. Several aspects have been proposed for the evaluation of generated ideas, e.g., quality, novelty and creativity (Dean et al., 2006). Thus, different conceptualizations from the literature inform how I evaluate ideas. For example, I understand the *quality* of ideas that relate to values in terms of their moral import (intrinsic versus instrumental values) and the sustainability dimensions that they relate to (e.g., economic or social). This results in the formulation of more specific questions related to the three main research questions of this thesis, see Section 2.4.4 “Comparing Ethical Perspectives on Values”, Section 2.5.2 “Traditional versus Value-based Roadmapping”, and Section 2.5.4 “Traditional and Value-Based IT Innovation Strategies”.

2.1 IT Innovation and Design

Design and innovation intersect in the development of technological products and service. Both share a focus on solving problems by finding a successful technical solution while dealing with the reduction of complexity (Hauschildt & Salomo, 2011; Stolterman, 2008) in various phases, including “ideation”, “divergence”, “convergence”, and “synthesis” (Phaal & Muller, 2009). Also, the consideration of stakeholders is important both from an innovation and a design perspective. And still, the foci of innovation and design differ. Traditional innovation management tries to achieve competitive advantage for the organization through technological products or services, while design approaches focus on creating user-centred products and services. When I refer to “innovation” in the following, I address the comprehensive task of managing a technological product or service from its initial ideation phase throughout development and up to the maintenance phase. When I refer to “design”, I highlight the initial phase of this task, which involves specific requirements and issues and tries to find a concrete solution that is applicable for the specific context.

In the following, I provide an overview of important concepts and developments. Creativity can be identified as the common denominator of design and innovation (see Section 2.1.1) and forms a core concept in my comparison of traditional technology roadmapping and an ethics-based approach (see Section 2.5.2). In Section 2.1.2, I review the ethical considerations in traditional IT innovation, which are constrained to the consideration of potential risks and the inclusion of stakeholders. In contrast, a look at historical developments shows that design, especially in HCI, has proposed many interesting approaches that try to take ethical implications of technology for humans more seriously (Section 2.1.3), some of which have taken up the concept values. As ethical considerations have not yet been fully incorporated in common IT innovation approaches, I outline what such an ethical approach with a focus on values could look like in Section 2.1.4.

2.1.1. Creativity as Common Ground

From an information systems perspective, design is the "creative process" aimed at coming up with an "innovative product", an IT artefact, which is able to solve a particular organizational problem (Hevner et al., 2004, p. 78). This shows that IT innovation, technology design and creativity are deeply interrelated concepts. Product innovation, then, explicitly deals with the "creation and introduction of new (technologically new or significantly improved) products which are different from existing products" (Edison et al., 2013, p. 1394). From a business perspective, this is important as it enables offering new products and services to customers or increasing efficiency in processes, which should ultimately lead to an increased economic success of the company. After all, innovation is what drives economic development and growth, due to new products being invented, developed, and placed on the market, and this is often triggered by technological developments and new skills.

The generation of new ideas is not only the starting point of any innovation process (Amabile, 1997), but also a core characteristic of creativity (Batey, 2012). Creativity is defined through various aspects such as usefulness and appropriateness (e.g., Erez & Nouri, 2010), which set it apart from innovation. And still, it is not surprising that the notions of creativity and innovation are sometimes used synonymously (Martins & Terblanche, 2003) as creating something new lies at the core of both innovation and creativity (Amabile, 1997; Batey, 2012; Erez & Nouri, 2010; Han, Forbes, & Schaefer, 2019; Runco & Jaeger, 2012). The *newness* aspect has been defined in different ways. In the classic innovation literature, Rogers and Shoemaker (1971) define "new" as whatever is perceived as new, which can also show itself as new knowledge or a new attitude: "An *innovation* is an idea, practice, or object perceived as new by an individual. ... If the idea seems new to the individual, it is an innovation" (p. 19). Hauschildt and Salomo, on the other hand, emphasize that "new" in the context of innovations cannot just refer to a gradual change or improvement of a technical problem; rather, innovations refer to "qualitatively new products or processes that 'noticeably' distinguish themselves—however this is to be determined—from a comparable situation" (p. 4). In creativity theories, novelty is usually understood as *originality*, a constitutive aspect of creativity (Batey, 2012; Dean et al., 2006; Runco & Jaeger, 2012): "if something is not unusual, novel, or unique, it is commonplace, mundane, or conventional; it is not original, and therefore not creative" (Runco & Jaeger, 2012, p. 92).

There are various ways to operationalize creativity based on different theories, models and levels (Batey, 2012; Wang & Nickerson, 2017). According to the 4Ps theory of creativity (Rhodes, 1961), creativity can be understood in terms of the creative process, the creative person (or trait), the creative product and the creative environment (or press). Amabile (1982) argued that "a product-centered operational definition is clearly most useful for empirical research in creativity" as "any identification of a thought process as creative must finally depend on the fruit of that process—a product or response" (p. 1001), and the same goes for the identification of a creative person. This argument is based on the view that processes occur within a person to produce a product and has led to the dominance of the product-oriented definition of creativity (Batey, 2012).

2.1.2. Consideration of Risks and Stakeholders

While an *invention* refers to any new idea, an *innovation* is a new idea that is developed or implemented, sold, used, and ideally becomes prevalent on a market (Hauschildt & Salomo, 2011). A core characteristic of an innovation is thus its successful implementation (Martins & Terblanche, 2003). Success can only grow from an ongoing exploitation of an innovation, which, in turn, makes the consideration of potential risks essential (Hauschildt & Salomo, 2011). Potential risk factors include finding a technical solution to the problem (technical risk), launching the product within time and expected costs (time and cost risks) and achieving customer acceptance (exploitation risk; Specht, Beckmann, and Amelingmeyer, 2002). This last aspect, the exploitation risk, is of special interest, as the success of an innovation heavily depends on future customers' attitudes and, consequently, what these attitudes are influenced by (Specht et al., 2002). If either an individual's general attitude towards change or their specific attitude towards the innovation is positive, an adoption is more likely; if it is negative, a rejection is more probable (Rogers & Shoemaker, 1971).

Technology design can consider lists of ethical principles or try to avoid known threats by acknowledging existing knowledge on opportunities and risks. This is especially helpful in the technology context, as dealing with technology inevitably involves uncertainty, especially when new technologies are being designed and developed (Bonnín Roca, Vaishnav, Morgan, Mendonça, & Fuchs, 2017; Dissel et al., 2009) and risks cannot be anticipated. Classic innovation literature already emphasized the importance of an innovation's *compatibility*, that is, "the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of the receivers" and "the prevalent values and norms of the social system" (Rogers & Shoemaker, 1971, p. 22f). For a successful diffusion of a new product, the needs and preferences of potential future customers, the superiority of the product with respect to competing products as well as the resulting customer benefits need to be determined (Hauschildt & Salomo, 2011). So, if an innovative IT product bears many positive values and resonates with the desires of a diverse set of stakeholders, then its chances of being successful are increased.

This claim forms a core idea in stakeholder theory, which states that corporate strategies should take into account all persons and groups with interests in corporate activities that could have an impact on corporate decisions (Freeman & Reed, 1983). Including stakeholders beyond shareholders and customers is vital since innovation is not only relevant for businesses and their economic success, but for society as a whole. New ideas can result in changes both at the level of the individual and of the social system (Rogers & Shoemaker, 1971). In times where ongoing technological developments and emerging technologies meet global challenges such as social injustice, it is crucial to consider the effects that new inventions and their diffusion have on social systems (Rogers & Shoemaker, 1971).

Still, the core claim defended by stakeholder theory is that stakeholders should be considered not because of their potential value to the shareholders, but for their own sake (Donaldson & Preston, 1995). Stakeholders refer to "any identifiable group or individual who can affect the achievement of an organization's objectives or who is affected by the achievement of an organization's objectives" (Freeman & Reed, 1983, p. 91) and can be "identified by their interests in the corporation" (Donaldson and Preston, 1995, p. 67). Theoretical analyses and top-down approaches have been complemented by design approaches and methods that focus on the inclusion of the perspective of those affected by a specific technology system, leading to, e.g., *participatory design* (Kuhn & Muller, 1993). The involvement of stakeholders has another theoretical origin in Habermas's (1993) discourse ethics, which "pushes us to consider, and involve, as wide a range of stakeholders as possible in decisions and systems design" (Dennis, Garfield, Adoption, Mingers, & Walsham, 2010, p. 844).

The consideration of various stakeholders is also key for value-oriented approaches. VSD emphasizes the importance of not only including those stakeholders that are directly affected by a technology (e.g., the users), but also those that are indirectly affected: "Stakeholders in VSD are not only the clients or end-users, but all people involved directly or indirectly in creating, using or being affected by the new technology" (Friedman, Kahn, Borning, & Huldtgren, 2013, p. 87). This extends to developers and researchers as much as other people that indirectly and even unintentionally interact with a technology. *Stakeholder inclusiveness* also forms a core principle in VBE (Spiekermann, 2023), which metaphorically sees stakeholders as "the visitors and keepers of the new technical garden" (p. 60) and invites them to contribute their perspective to the value elicitation phase. Thus, the consideration of risks and potential adverse effects of an innovation and the identification of a diverse group of stakeholders are important aspects that need to be considered in any ethically aligned innovation process.

2.1.3. Shifting Paradigms in Technology Design

The history of computing has met technological and organisational problems that historically ranged from hardware constraints to software and further to user relations constraints and have led to the current *technology/society/identity* phase, which is concerned with "questioning the boundaries between IT, society and individuals, with technical problems relating to standardisation and interoperability, and societal concerns centred upon issues relating to privacy, surveillance and access" (Brigham & Introna, 2007, p. 2). One of the most noteworthy changes that occurred in the past decades is the fact that computers are no longer a subject reserved for experts. In the form of ubiquitous information technology applications and devices, computers have become something that everyone is confronted with and, in the wider business context, that everyone needs to manage in one form or another (Boaden & Lockett, 1991). These developments heavily influenced how technology plays out in the organisational context. They also affected the technology development process, which had initially focused on computational capacity and functionality but over time made space for human aspects of the interaction process, and thus, technology *design*.

In many technology design approaches that have developed, human factors form a core concept driving the design process. Approaches such as *user-centred design* work "from the outside in, from the end user's needs and abilities to the eventual implementation of the product" (Rubin & Chisnell, 2008, p. 12). Don Norman's *human-centred design* focuses on "ensuring that people's needs are met, that the resulting product is understandable and usable, that it accomplishes the desired tasks, and that the experience of use is positive and enjoyable" (Norman, 2013, p. 44). With this perspective, new requirements were set. *Usability* became a primary goal in technology design, making the use of an information technology easy and fast. In order to achieve such a design, designers needed to understand the human perspective as "things are designed to be used by people, and without a deep understanding of people, the designs are apt to be faulty, difficult to use, difficult to understand" (Norman, 2013, p. 44). This implied a shift towards human factors such as cognitive capacity, perceptual processes and related concepts such as affordances (Gibson, 1979/1986). Later, design methods and trends again shifted their focus away from mere *usability*, which is nowadays considered a basic criterion that needs to be met, towards creating a great *user experience* (UX) to enhance the desire to use information technology (Anderson, 2011).

Current prevailing approaches such as design thinking (Brown, 2009) start from the users' needs and aim at a human-centred technology design. Interestingly, new trends now criticise this human-centeredness in HCI and call for removing the stress on "human" in order to make space for a view that emphasizes the interrelatedness of humans and technology (Frauenberger, 2019). It is yet to be seen how this new shift will affect related fields of research and practice. More importantly, problematic consequences stemming from information technology use have once again raised the bar for good technology design. In addition to the requirements that have been defined in the past, current technology design needs to address potential social and ethical issues that could arise from the use of the respective technology. Values provide a promising concept in this regard as they can be used to represent social and ethical considerations such as privacy in technology design (van de Kaa et al., 2020). As I argue in more detail below (see Section 2.2.1), values differ from concepts that have been used in HCI such as needs and goals. With their focus on vital and biological interests and the direction of specific actions, both needs and goals can only provide a limited representation of what drives human behaviour.

2.1.4. Envisioning Ethical IT Innovation

Cooper et al. (2014) argue that a fundamental reason why many digital products fail is to be found in a company's misplaced priorities on market trends and technical constraints, which ignore the perspective of the users, their needs and desires. Marketers focus too much on "chasing the competition, managing IT resources with to-do lists, and making guesses based on market surveys" while developers are busy "solving challenging technical problems, following good engineering practices, and meeting deadlines" (Cooper et al., 2014, p. 7). Here, the need for IT innovation processes to take future users and customers and the value effects of the technology on indirect stakeholders more seriously becomes apparent.

Porter and Kramer (2011) have emphasized the importance of taking customers into account:

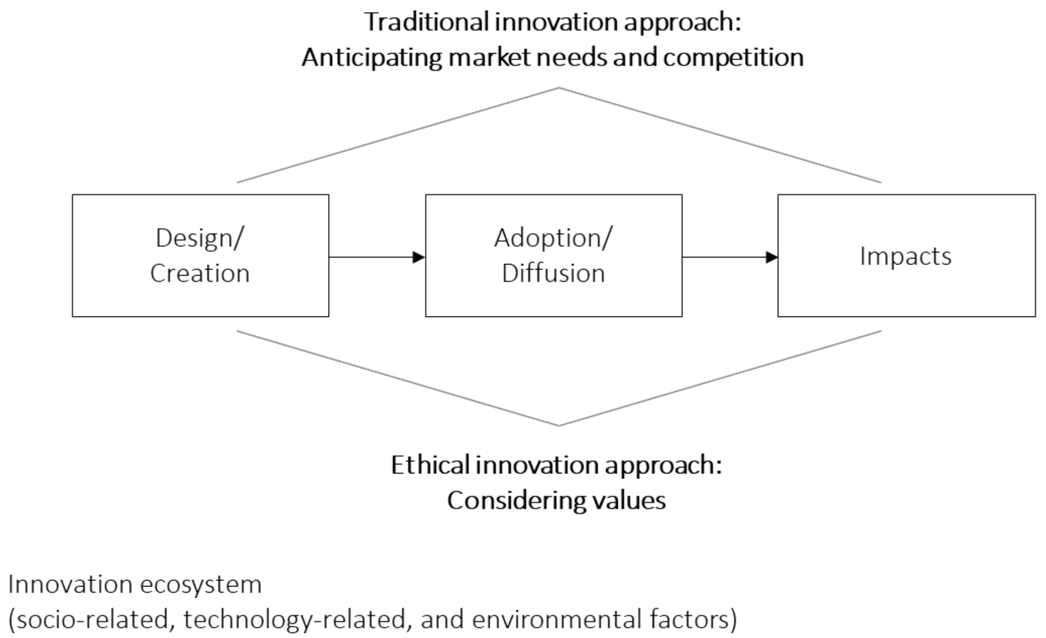
> In business we have spent decades learning how to parse and manufacture demand while missing the most important demand of all. Too many companies have lost sight of that most basic of questions: Is our product good for our customers? Or for our customers' customers? (p. 7)

They argued that companies can increase their profit by at the same time targeting society's challenges and human needs, leading to *shared value* (Porter & Kramer, 2011). However, The Economist (n.d.) responded to the shared value concept critically, saying that Porter's "new big idea … seems a bit undercooked". More recently, Kettner (2017) has argued that the concept of creating shared value has been promoted as "the glorious reinvention of capitalism" while still allowing "to stay firmly within today's capitalism's comfort zone without essentially changing anything" (p. 159). Most importantly, the "value" that forms the core aspect of this approach is understood in terms of economic benefits, savings, or revenues. This notion ignores wider social implications and lacks any moral import. This is not surprising, considering that ethical considerations are rarely connected to innovation management explicitly.

It is representative here that the keyword "ethics" cannot be found once in the textbook on innovation management by Hauschildt & Salomo (2011) or in the more alternative *business of humanity* management approach (Camillus et al., 2017). And still, "ethics and technology are connected because technologies invite or afford specific patterns of thought, behavior, and valuing; they open up new possibilities for human action and foreclose or obscure others" (Vallor, 2016, p. 2). What is more, Martin et al. (2019) expressed that "the most direct means of addressing ethical challenges in new technology is through management decisions within technology firms" (p. 309). Thus, any IT innovation approach ideally takes ethical implications of the technology into consideration, where values form a promising concept to guide ethically aligned design. If value issues are addressed from the start, technological innovation can incorporate "moral, social, and personal values" into the design processes and thus result in "morally and societally responsible technology innovations" (van den Hoven, Vermaas, & van de Poel, 2015a, p. 2).

In line with this, scholars have called for corporate innovation to show how it accommodates *values* (Martin et al., 2019; Nonaka & Takeuchi, 2011). Spiekermann's (2016) approach to *ethical IT innovation* represents pioneering work in that it proposes a theoretical framework on how ethical thinking and values can be systematically integrated into system development life cycles. Spiekermann proposes to integrate core aspects of three theories of ethics—utilitarianism, deontology, and virtue ethics—in IT innovation to achieve a value-based design of IT products and services. Such an ethical innovation approach goes far beyond the traditional innovation focus on market needs and competition by extending considered values to include not only economic success, but a variety of values that are relevant for affected stakeholders, e.g., privacy, safety, or accountability. When employed throughout the system development life cycle, as envisioned by Spiekermann (2016), a value-based understanding of an innovation's impact can help to influence its design so that it fosters positive values and avoids negative values. This, in turn, makes the adoption and ultimate success of an innovation more likely. This thesis investigates the potential of such an ethics-based approach with a focus on values as an alternative framework for the innovation process, which Figure 2 depicts from a simplified information systems perspective.

Figure 2. A simplified view of traditional versus ethical innovation
(adapted from Jha & Bose, 2016; Xiao, Califf, Sarker, & Sarker, 2013)

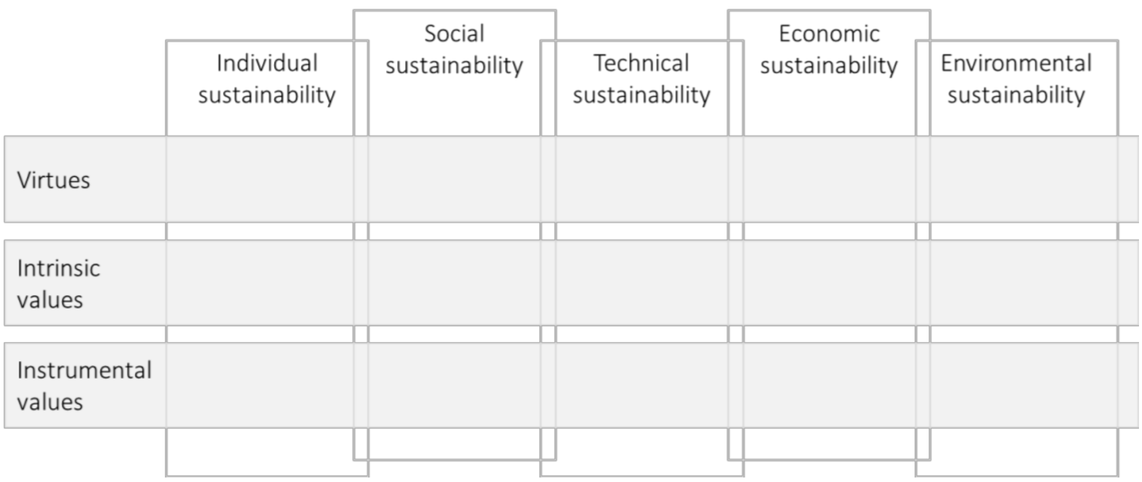


2.2 The Concept of Values

In the following, I discuss the definitions and characteristics of values as well as related challenges. Most importantly, the openness of the concept of values has led to the use of the term “value” or “values” in various contexts without an appreciation for the wider moral connotation. As values form the core concept of this thesis, the following sections introduce the concept of values and important characteristics of the concept that make it relevant and useful for an ethically aligned technology design. First, I review different definitions of values (Section 2.2.1). Then, I discuss how values have been located in the interaction of humans and their environment (and with it, technology; Section 2.2.2). Most importantly, I argue that values have a moral foundation (Section 2.2.3), which can be explored through the differentiation of instrumental and intrinsic values, virtues (Section 2.2.4) and the principle of sustainability (Section 2.2.5). In the last section, I conclude that because of their flexible and normative character, values are “big words” (Section 2.2.6) that can guide technology design.

A value framework (Kheirandish, Funk, Wensveen, Verkerk, & Rauterberg, 2020) forms the basic structure for a concept of values and categories for value groups. The value framework that I propose in this thesis can help to promote an understanding of values in technology design that emphasizes ethical considerations for various affected stakeholders. As I will argue below, I embrace an understanding of values that combines aspects of Scheler's (1913-1916/1973) value ethics with the current discourse on values in technology design by including a special focus on the differentiation between instrumental and intrinsic values (van de Poel, 2009). In Figure 3, I outline a value framework that combines sustainability dimensions with the moral height of intrinsic and instrumental values as well as virtues.

Figure 3. Value framework



Note. In the figure, only neighbouring sustainability dimensions are portrayed as overlapping. However, sustainability dimensions can theoretically overlap in all possible combinations (Penzenstadler & Femmer, 2013; Winkler & Spiekermann, 2019).

2.2.1. Defining Values

The concept of values is generally difficult to define and there is no agreed definition of values (de Graaf & van der Wal, 2008). While the term "value" or "values" is common in many areas and repeatedly comes up in, e.g., political discussions or economic considerations, its meanings differ widely. While it is not my aim to come up with a new definition of values, conciliate positions or defend a specific position, I want to expand on some aspects of values that are relevant for this thesis in the following sections. A first differentiation can be made between the traditional economic understanding of "value" in terms of financial success, monetary benefits and revenues (e.g., Dissel et al., 2009; Pham et al., 2013) or customer value (e.g., Storey, Cankurtaran, Papastathopoulou, & Hultink, 2016). This is in contrast with the much broader understanding of *human* or *social* values that I embrace, which includes well-being (Brey, 2015), freedom of speech, rights to property, accountability, privacy and autonomy (Friedman, 1997), among many others.

More importantly, concepts of values rooted in psychology often emphasize the subjectivist side of valuing. In the understanding of Rokeach (1973), a value is "an enduring belief that a specific mode of conduct or end-state of existence is personally or socially preferable to an opposite or converse mode of conduct or end-state of existence" (p. 5). Schwartz (1994) defined values as "a belief pertaining to desirable end states or modes of conduct that transcends specific situations; guides selection or evaluation of behaviour, people, and events; and is ordered by the importance relative to other values to form a system of value priorities" (p. 20). Similarly, Pereira and Baranauskas (2015) focus on values "as self-related motivating forces, which thus have the potential to give meaning to situations and to energize and regulate behaviour" (p. 445). Opposed to the understanding of values as *beliefs*, Cheng and Fleischmann (2010) present definitions of values as *conceptions* (e.g., Kluckhohn, 1962) and *principles* (e.g., Braithwaite & Blamey, 1998), which lie much closer to the concept of values that I embrace in this thesis. For example, Kluckhohn (1962) defined values as "a conception, explicit or implicit, distinctive of an individual or characteristic of a group, of the desirable which influences the selection from available modes, means, and ends of action" (p. 395). Shilton (2018) takes it even further when she expresses that "within the realm of the normative, values can be attributes of people, attributes of systems, tools to think with, or even actions to take" (p. 128). It is difficult to judge which conceptualization of values is "right" or "better". However, it is important to stress that I support a concept of values that is not subjective and argue that values go beyond other concepts that have been used in HCI such as needs and goals because of their moral import.

The widely used conceptualization of values as "desirable transsituational goals, varying in importance, that serve as guiding principles in the life of a person or other social entity" (Schwartz, 1994, p. 21) stresses the commonalities of values and goals. Similarly, Gorgievski, Stephan, Laguna, and Moriano (2018, p. 458) define values as "abstract and important goals people strive to achieve in life". Both goals and values might represent something that people seek to achieve. And yet, values are distinct from goals. Goals represent cognitive objectives of the individual (Jolibert & Baumgartner, 1997), small, local units of analysis that are easy to analyse but can only provide an isolated view on what drives human action and perception (Hodges & Rączaszek-Leonardi, 2022). Values, in contrast, "are essential to defining and evaluating actions; they provide the larger context in which laws, rules, and goals function" (Hodges & Rączaszek-Leonardi, 2022, p. 87). In their example of car driving, Hodges and Rączaszek-Leonardi (2022) enlist accuracy, tolerance, safety, justice, and trust as exemplary values that together direct the driver's actions. This interplay of values goes far beyond what could be explained by any singular goal such as the goal to drive accurately. What is more, values represent social norms (Jolibert & Baumgartner, 1997) that guide individuals' actions, often without them being aware of it (Hodges & Rączaszek-Leonardi, 2022). In contrast to values, goals could never help to "evaluate certain objects or state-of-affairs as good or bad and beautiful or ugly" (van de Poel and Kroes, 2014, p. 108). Yet, values cannot be reduced to social norms, they are "neither subjective nor objective" (Hodges & Rączaszek-Leonardi, 2022, p. 87) but lie in the relationship of a subject acting within an environment (Fuchs, 2020; Hodges & Rączaszek-Leonardi, 2022).

Another parallel is often drawn between the concept of *needs* and values. Maslow (1943) proposed physiological needs, safety needs, love needs, esteem needs, and the need for self-actualization in his theory of motivation. Spiekermann (2016) aligned Maslow's hierarchy of needs with values identified in psychology and philosophy (Frankena, 1973; Krobath, 2009), resulting in a structured arrangement of selected values, with health as one of the most basic values for a person and achievement as a higher value for human motivation and thriving. However, values go beyond human needs because they represent what matters to humans, what they value, strive for and seek to protect. While needs express the biological and vital interests and desires of an individual, values such as human dignity imply "universal moral attitudes, which no longer correspond to any primary personal or group interest" (Fuchs, 2020, p. 25). Because of this characteristic, values extend to include moral considerations.

To summarize, values differ from needs and goals in aspects that are of high relevance for an ethically aligned technology design. Values are not just personal judgments or convictions—they are not just what "I think" or "I desire" (subjectivist positions), but are independent of individual judgment (Spiekermann, 2023). The notion of values can be reduced neither to the quality of an object nor to a person's desires, preferences, needs or goals. Instead, values lie within the subject-object interrelation.

2.2.2. Locating Values Within the Subject-Object Relation

In the literature on values, the particular terminology used reveals assumptions on the underlying theoretical concept, specifically with regard to the assumed location of values within the subject-object relation. For example, phrases that express that an individual "holds" values (Fleischmann & Wallace, 2010, p. 57) implies a subjectivist position, which derives values from individual preferences (Fuchs, 2020). In contrast, phrases such as "technical artifacts ... embody values" or "values may be designed into technical artifacts" (van de Poel and Kroes, 2014, p. 121) seem to imply that values can be localized within objects. Moving away from seeing values solely as "qualities inherent in objects" (Schwartz, 1992, p. 1) is important for a technology design approach that tries to acknowledge the wide spectrum of human, social, and ethical values. While there is some agreement that values are qualities and cannot be reduced to their being in objects, there are various accounts in technology design and philosophy on *what* and *where* values are.

Scheler (1913-1916/1973) emphasized that value is not "situated on a thing" (p. 22), arguing instead that values are "pure qualities" (p. 104). VBE (Spiekermann, 2023) borrows from Scheler when using terms such as *value dispositions* to describe characteristics of the technology system that support specific *value qualities* perceived by persons. De Graaf and van der Wal (2008) also defend the view that values are essentially "qualities", but see values dependent on their manifestation: "values never come just by themselves; they never appear unaccompanied; values are always attached to a value manifestation and express a quality" (p. 84). In contrast, for Scheler (1913-1916/1973) values were independent from the things that bear these qualities, values are "*a priori* to such a world of goods" (p. 23).

Fuchs (2020) proposes a mediating position that neither localizes values within the subject, nor within the thing, determining values as relational phenomena. According to Fuchs, the subject recognizes the positive or negative value of an action, a situation, or a person through affection and emotion—an account that bears similarities with Scheler (1913-1916/1973), who considered values "clearly feelable" (p. 34). And still, the understanding of values as *relations* is opposed to Scheler's understanding of values as *qualities*. Fuchs (2020) defends the relational quality of values as it ties biological values to the "coupling of organism and environment" (p. 30) and explains higher values through social-interactive processes that involve "second order evaluations" (p. 34). In contrast, Scheler (1913-1916/1973) emphasized the importance of the human ability to perceive values, but clearly ruled out that "the experience of values ... depends in any way on the experience of the bearer of the value" (p. 17).

Fuchs' (2020) understanding relates to the concept of *affordances*, a concept that can help to better characterize and understand the object-value relation. Originally defined by J. J. Gibson (1979/1986), affordances refer to the possibilities and opportunities for action that the environment presents to an organism. Affordances are relational in that they represent potential actions and consequences that the environment affords to an individual, which in turn depend on the capabilities and needs of the perceiving organism. Hodges and Baron (1994) argue that values play a central role in Gibson's theory of affordances as they shape the possibilities and consequences that a person perceives within a given environment. For example, an object or a physical environment may carry the value of safety, and this value influences how individuals perceive the affordances offered by that object or environment. They may see it as a secure and reliable resource, leading them to engage with it in a particular way. In this way, values act as guiding principles that shape the perception of affordances and influence people's decision-making and behaviour (Hodges and Baron, 1994). This understanding highlights the dynamic interplay between values, affordances, and the interactions between individuals and their environment.

VSD further emphasizes the role of the person interacting with a technology. VSD sees values not as "embedded" within a technology but as "implicated through engagement" (Davis & Nathan, 2015, p. 15). This *interactional* view of values emphasizes that users' interaction with the technology also determines how values play out in a technology:

> Values are viewed neither as inscribed into technology (an endogenous theory), nor as simply transmitted by social forces (an exogenous theory). Rather, the interactional position holds that although the features or properties that people design into technologies more readily support certain values and hinder others, the technology's actual use depends on the goals of the people interacting with it. (Friedman et al., 2006, p. 361)

Other views of values go even further and stress the process of valuing that precedes values: "people do not experience values as out there, readymade, waiting to be identified; they experience values as the evolving product of human valuing processes, and as such values are living phenomena, interactive and dynamic" (Boenink & Kudina, 2020, p. 2).

2.2.3. Values Have Moral Import

Only an understanding of values that moves beyond the notion of an object's value or "quality of being useful and important" (Kheirandish, Funk, Wensveen, Verkerk, & Rauterberg, 2020, p. 2) can guide ethical technology design. In order to translate ethical principles into principles guiding technology design, that is, to bridge ethics and design (Timmermans et al., 2011), values must not be used merely to represent goals or needs but "to distinguish that which should be, as opposed to that which is" (Shilton, 2018, p. 128). While current value-oriented approaches such as VSD embrace a pluralist understanding of human and social values, they have been criticized for not providing an ethical justification for their concept of values.

VSD scholars commonly define values as "what people consider important in life" (Friedman et al., 2006, p. 12) with a "focus on ethics and morality" (Friedman & Hendry, 2019, p. 4). This definition originates in the Oxford English Dictionary, where values are described as "the principles or standards of a person or society, the personal or societal judgment of what is valuable and important in life" (Simpson and Weiner 1989, as cited by Friedman et al., 2006, p. 368). It is difficult, though, to evaluate whether the concept of values underlying VSD entails a moral foundation. It seems that "what a person or group of people consider important in life" captures anything that people appreciate and desire and hence is subject to the criticism that values capture only subjective preferences (Reijers & Gordijn, 2019).

It has been argued before that a "value is not just a preference but is a preference which is felt and/or considered to be justified—'morally' or by reasoning or by aesthetic judgments" (Kluckhohn, 1962, p. 395). Different theories of values have come up with different solutions for this "justification". For example, Kluckhohn (1962, p. 422) argued that a "value is more than mere preference; it is limited to those types of preferential behaviour based upon conceptions of the desirable". VBE (Spiekermann & Winkler, 2020), on the other hand, builds on the philosophical understanding of values as *ought-to-be* principles that should guide human behaviour (Hartmann, 1932; Scheler, 1913-1916/1973).

In his non-formal ethics of values, Scheler (1913-1916/1973) stressed that "being good" and "being evil" is dependent on the realization of values. He makes this explicit in his formulation of axioms such as “good is the value that is attached to the realization of a positive value in the sphere of willing” (axiom II. 1.) and “evil is the value that is attached to the realization of a negative value in the sphere of willing” (axiom II. 2., p. 26). For Scheler, “good” and “evil” were “primary non-formal values” (p. 25) which appear when realizing a relatively higher/lower value or the highest/lowest value. The “being-higher of a value” (p. 25) is given in the act of *preferring*, from which follows that an act is morally good if it realizes a value that is “preferred” (p. 25f). Importantly, there are positive and negative values, and realizing a positive value is good whereas realizing a negative value is evil (p. 26). For example, “activity” can be considered a positive value that has a counterpole in the negative value “inertia”.

This is a first helpful categorization of values that can guide moral actions and decisions of designers when deciding on a technology’s characteristics. Based on Scheler's axioms (1913-1916/1973, p. 26), Table 1 summarizes the effects of value realizations in terms of good/evil or positive/negative.

Table 1. The realization of positive and negative values (adapted from Scheler, 1913-1916/1973, p. 26)

	Positive value	Negative value
Existence/Realization	Positive	Negative
Non-Existence	Negative	Positive

Scheler's (1913-1916/1973) value ethics provides a strong connection between values and the notion of good and right. However, how he describes the ultimate source of goodness is controversial. Scheler placed the “divine” or “infinitely holy” (p. 94) highest in the order of value ranks. It is difficult to imagine how this could be translated into the technology design context. What is more, it is unclear how Scheler's (1913-1916/1973) non-formal ethics with its focus on value-ception can guide technology design practices: How can we make a designer become someone “who feels values livingly and adequately, and for whom a certain value flashes out in its own rank in the act of preferring” (p. 201)?

A different approach trying to justify the moral import of values provides a possible solution by emphasizing the importance of ethical reflection. The basic idea is that the moral foundation of values lies in a second-degree-desiring or reflection. Values are what we desire to desire, which reflects the human ability “to take a stance toward one’s own desires” (Fuchs, 2020, p. 34). The so-called *second-order desires* or *volitions* have been defined by Frankfurt (1988) and referred to by Wallach and Vallor (2020) as well as Fuchs (2020). Frankfurt (1988) points out that that being aware of our desires and being able to reflect on whether a desire represents what we *want to desire* or not is a deeply human ability and characteristic. Through this second-order stance we can "reflectively desire to be the better version of ourselves that we currently are not" (Wallach & Vallor, 2020, p. 402). And still, Kroes and van de Poel (2015) emphasize that such evaluations depend on second-order value judgments, for which we have no established theoretical framework, making it difficult to assess whether a value resulting from ethical reflection has indeed moral import.

2.2.4. Intrinsic/Instrumental Values and Virtues

Turning to the literature, it becomes evident that different arguments have been proposed to show that a set of values is important in a higher sense. A first difference can be made between instrumental and intrinsic values. Values can capture what is good *instrumentally* to achieve what is good *intrinsically*, that is, good and valuable in itself (Hartmann 1932; van de Poel 2009; Scheler 1913-1916/1973; Spiekermann 2016). In general terms, intrinsic value is "value that is not a matter of their tendency to contribute to or make possible something else which is of value" (Scanlon, 1998, p. 79). It is a "good in itself, and not because it is a means to another end or contributes to another value" (van de Poel 2009, p. 975). Examples for intrinsic values could be happiness or health. Instrumental values, then, are "a means to achieving a good end, i.e., another positive value" (van de Poel 2009, p. 976). In technology design, examples for instrumental values could be ease of use or transparency. Intrinsic values have been discussed as sources or instances of "the good" and can thus be considered as "higher" and ethically more important than instrumental values. For example, Ross (1930) discusses virtue, knowledge, and pleasure, as "intrinsically good things" which are "good throughout" (p. 69) in which "are compounded all the complex states of mind that we think good in themselves" (p. 141).

Scheler (1913-1916/1973) presented an extensive discussion on the height of values, which is ultimately grounded in notions of "good" and "evil" as "primary non-formal values" (p. 25) and the "holy" as "the *most indivisible* value" (p. 94). Scheler also described several criteria that communicate the height of a value. He argued that values are higher when they are experienced as deeper, more durable and fulfilling, and do not depend on other values (Scheler 1913-1916/1973, p. 90): "It appears that values are 'higher' the more they *endure* and the *less* they partake in *'extension'* and *divisibility*.; they are higher the *less they are 'founded'* through other values and the *'deeper'* the *'satisfaction'* connected with feeling them." These criteria can offer orientation when differentiating between values.

Next to instrumental and intrinsic values, there is a third group of human values inherent in the good character and conduct of a person: virtues. More recently, virtues have experienced a renaissance in the field of computer ethics (Vallor, 2016). A virtue is "a disposition, habit, quality, or trait of the person or soul, which an individual either has or seeks to have" (Frankena 1973, p. 64). Examples are honesty, courage, loyalty, or humility. According to Aristotle (2004), virtues allow the bearer to live in true happiness. Thus, virtues are grounded in normative theory. Of course, virtues differ from other values as they are bound to a person's character. And still, Scheler (1913-1916/1973) described virtues and vices as "what we are 'able to do'" (p. 129) with regard to "areas of the ideal ought … construed in terms of moral values" (p. 28) and he argued that "virtue (and vice) is a foundation for the moral value of all particular acts" (p. 28). Scheler further claimed that "all properties of the person that vary (according to rules) with the *goodness of the person* are called virtues; those that vary with the person's being-evil are called vices" (p. 85). Similarly, Ross (1930) lists virtue as the highest intrinsic value where the virtuous desire "to do one's duty is the morally best motive" (p. 164). Thus, virtues represent an important pool of values located at the level of, if not comprised by, intrinsic values.

2.2.5. Sustainability and Values

Other principles that have been connected to values could also be seen as an indicator for moral import. One of the principles that has attracted increasing attention recently is the principle of sustainability. The standard definition of sustainability originates in the so-called "Brundtland Report" published by the World Commission on Environment and Development (WCED; 1987), where *sustainability* is referred to as the "ability to make development sustainable—to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" (p. 8). Social, economic, and environmental sustainability are also mentioned in the Sustainable Development Goals (SDGs) formulated by the United Nations (n.d.). In a broader understanding of the term, sustainability refers to individual, social, economic, environmental, and technical sustainability (Penzenstadler & Femmer, 2013).

The principle of sustainability lies close to moral responsibility and can thus provide an additional ethical perspective on values in technology design. In his book "The Imperative of Responsibility", Jonas (1984) argues that when we deal with technology, we need to consider future developments: "The containment of nearness and contemporaneity is gone, swept away by the spatial spread and time-span of the cause-effect trains which technological practice sets afoot, even when undertaken for proximate ends" (p. 177). Such a concern is still anthropocentric, as is all traditional ethical theory (Jonas, 1984; Shearman, 1990). Still, it opens up the moral space for considerations of time and the natural environment, which are essential characteristics of sustainability (Shearman, 1990), but dimensions that are not typically acknowledged in technology design.

Against this background, sustainability is an interesting principle to be taken into consideration. Not only does it cover several dimensions, but it also features an inherent appreciation of the future and future generations. Kibert, Monroe, Peterson, Plate, and Thiele (2012) argue that sustainability serves as a good principle to guide ethical decision-making as it incorporates ethical principles that deal with how moral concerns extend to the social space of duty, utility, or the golden rule, and further includes moral concern across time. The more recent literature has suggested that the principle of sustainability is interesting as it can be translated into technology design with the use of values (Penzenstadler & Femmer, 2013; Winkler & Spiekermann, 2019). In Section 3.4.4, I make use of this concept in the categorisation of value ideas resulting from the empirical investigations in this thesis.

2.2.6. Values: "Big Words" Bridging Technology Design and Ethics

Values can help to bridge the gap between ethics and technology design (Cummings, 2006; Timmermans et al., 2011) by providing guidance for the consideration of abstract ideas and principles of the good and right in concrete technology design decisions. They can provide this guidance because abstraction and generalization are important characteristics of values that put them on a different level than aspects of the immediate situation (Kluckhohn, 1962) and allow values to be defined and conceptualized based on established disciplines and the literature, e.g., moral philosophy and law (Kroes & van de Poel, 2015). At the same time, values are context-dependent as the moral relevance of values, the way they play out in a particular technology (Kroes & van de Poel, 2015) and the solution of value conflicts depend on context. For example, security might be valued over usability in a bank, but not in a school (Hulstijn & Burgemeestre, 2015). Thus, considering values that are relevant for a technology and affected stakeholders combines the specific design context with widely accepted principles. What is more, the abstraction from the immediate enables values to relate to the good as "conceptions … of the desirable" (Kluckhohn 1962, p. 395). Taken together, these characteristics turn values into *big words*, i.e., highly flexible but value-laden concepts with a normative connotation, which are often defined with reference to earlier usages and can clash with other concepts (Bos, Walhout, Peine, & van Lente, 2014). Just as big words such as sustainability can steer research (Bos et al., 2014), values can steer ethical technology design.

While intrinsic values can capture ethical implications of a technology, instrumental values are also important to consider. On the one hand, technology design has a creative component, for which a variety of ideas is important and helpful. But more importantly, instrumental values can help to translate important ethical principles into specific design requirements. In her recent book on VBE, Spiekermann (2023) describes this approach of translating core value principles down to system requirements in detail and a related case study shows that clustering values can help to reduce a long list of identified values to value clusters with few core values and many values that connect them (Spiekermann-Hoff, Winkler, & Bednar, 2019). Identifying the core values for a technology project can help corporate leaders and innovation teams to publicly commit to a set of ethical principles that they consider important and want to endorse (Spiekermann, 2023).

The generalization of values as well as their context-dependence are mirrored in the fact that technology design approaches focusing on values usually assume value pluralism (as opposed to value monism), aiming at the consideration of a variety of values that are relevant for a specific technology context. Value pluralism assumes the existence of a diversity of values (e.g., friendship, respect, autonomy) rather than one "supervalue" that all other values can be reduced to (e.g., pleasure; Chang 2015; Anderson 1993). For every technology and every context of use, a different set of values might be relevant. Importantly, values don't lose their importance because they are less relevant in a particular practical or cultural context (Verplanken & Holland, 2002). Despite such variations, values are universally appreciated across cultures (Schwartz, 1994). Scheler (1913-1916/1973) captured this quality of values by granting them to be *essences*, which he describes as "neither universal nor particular" (p. 48). He writes:

> Thus, an essence becomes *universal* if it comes to the fore in a plurality of otherwise different objects as an identical essence: in all and everything that "has" or "bears" this essence. The essence can, on the other hand, also constitute the nature of an *individual thing* without ceasing to be such an *essence*. (p. 49)

The varying importance of values in different contexts also creates challenges, resulting in value conflicts in public innovation (Meijer & De Jong, 2020), academic teaching (de Graaf, 2021) computational modelling (Fleischmann & Wallace, 2010), and technology design (van de Poel, 2015). Value conflicts appear in design situations where "one value will point in the direction of one particular design and another value in the direction of another" (van de Poel, 2015, p. 90). Van de Poel (2015) describes an example, where a designer has several options for designing a seat belt, which either supports drivers' *freedom* by letting them decide to put on the seat belts or not, or *safety* by enforcing the automatic use of seat belts; a third option is a seat belt with a warning signal, which tries to cater to both values, but scores only moderately in achieving safety and freedom, respectively. Which design option should the designer choose? Several ways to deal with conflicting values have been suggested (Miller et al., 2007; van de Poel, 2015). While the underlying problem persists, any value conflict can also be taken as an inspiration for coming up with new design options, spurring further innovation (van de Poel, 2015). When conflicting values are proactively addressed, the design of a technological product or service can be adjusted so that it accommodates a variety of values (Taebi et al., 2014). Through such a process, value conflicts can be used for "fine-tuning innovation" (Meijer & De Jong, 2020, p. 979).

2.3 Value-oriented IT Approaches and Current Challenges

Translating ethical principles to a specific technology context is not easily done. Working with values implies a difficult stretch between theoretical principles and specific technology contexts: In a particular technology project, values need to relate to the specific design context (Le Dantec et al., 2009; Reijers, 2018) to relate to how stakeholders are directly and indirectly affected by the technology design (Friedman et al., 2013) and propose ways in which the technology design should be adapted (Taebi et al., 2014). At the same time, values need an ethical foundation (Manders-Huits, 2011) to foster ideas and principles of the good and right without falling back to mere stakeholder preferences (Reijers & Gordijn, 2019) or previously established lists of values with moral import (Le Dantec et al., 2009; Reijers, 2018).

In the following, I discuss two common approaches that focus on values with moral import, the top-down adherence to lists of ethical values (Section 2.3.1) and the bottom-up discovery or elicitation of ethical values (Section 2.3.2). Both approaches are confronted with substantial criticism, which has motivated my investigation of a new approach in this thesis.

2.3.1. Top-down Challenges: The List-based Approach to Values

A common approach to an ethical technology design is to draw on lists of ethical principles, which provide sources for established values with justified moral import. Such lists have been published mostly by corporate, political or industry representatives and seek to apply ethical principles top-down to a technology context.

Jobin, Ienca, and Vayena (2019) identified 84 policy documents in the field of AI alone, which reach consensus on 11 shared values: transparency, justice and fairness, non-maleficence, responsibility, privacy, beneficence, freedom and autonomy, trust, sustainability, dignity, and solidarity. VSD scholars have provided similar lists of values, which include human welfare, ownership and property, privacy, freedom from bias, universal usability, trust, autonomy, informed consent, accountability, courtesy, identity, calmness, and environmental sustainability (Friedman et al., 2006). And still, VSD scholars would probably disagree that VSD "uses a pre-defined list of values" (Kheirandish et al., 2020, p. 2). As Kheirandish et al. add, the list(s) presented by VSD scholars are not intended to represent a complete list of values but rather to provide examples for frequent values in system design. Additionally, the endeavour to connect values to the principle of sustainability (Winkler & Spiekermann, 2019) has also resulted in a value list that comprises accountability, aesthetics, autonomy, community, dignity, education, efficiency, environment, equality, freedom, human capabilities, human health, human productivity, human welfare, human wellbeing, justice, knowledge, maintainability, peace, pleasure, privacy, property, relationship, reliability, reusability, respect for norms, security, simplicity, transparency, trust, and usability as *overarching values*.

These lists are helpful for the incorporation of ethical considerations into technology design as they point out important areas of human-technology interaction that have been identified as morally relevant before. The prominence of values such as accountability, explainability, and fairness in ethical guidelines such as the IBM (2018) "Everyday Ethics for AI" guide is certainly justified and desirable and can help to increase moral awareness in the organization. Still, applying values in a top-down manner by adhering to pre-established lists is problematic in at least three ways.

First, published guidelines predominantly focus on preventing value harms, i.e., on avoiding negative consequences, and tend to neglect the potential inherent in the active promotion of positive values (Jobin et al., 2019). However, Scheler (1913-1916/1973) has shown that there are positive and negative values and that both the nonexistence of negative values and the existence of positive values are good (see Table 1 above). In line with this, values can set constraints on design but should also help to uncover creative technological solutions (Shilton, 2013; Jeroen van den Hoven et al., 2012) and foster new forms of added value for companies (Spiekermann, 2016). When applied to a technology domain, an ethical approach should see value harms when a plane is not safe, a car engine is not environmentally friendly, or a social network is manipulative. However, it should also acknowledge positive value potentials, such as an algorithm's transparency or a robot's politeness. Otherwise, a mere negative vision on IT can lead to the conclusion that "the only proper technology is no technology" (Berg, 1998, p. 269, as cited by Brigham & Introna, 2007, p. 4).

Second, any predefined list risks to narrow the focus on values that are promoted through the list rather than the problem at hand (Friedman et al., 2017). Generally, technology development focuses on technical and economic values (such as efficiency and ease of use), while the social and environmental impact is neglected (Lago, Koçak, Crnkovic, & Penzenstadler, 2015). However, a truly ethical perspective should aim for a broadly sustainable technology design that acknowledges values relevant for the individual, as well as social, economic and environmental development (Penzenstadler & Femmer, 2013; van Wynsberghe, 2021; Winkler & Spiekermann, 2019). Development in this context can contribute to the protection of human dignity and health as well as the preservation of natural resources.

Third, value lists can be misleading as values are contextually bound. The digital devices and services used by people in different situations bear the values that unfold (Scheler, 1973). And it is because of these individual predispositions that some values unfold more than others for a respective person, even if he or she uses the same technology as someone else (Scheler, 1973). The consideration of broadly established values can lead to neglecting values relevant to the specific cultural context (Borning & Muller, 2012), the specific context of use, and the stakeholders affected by the technology (Pommeranz et al., 2012). Every technology embodies highly unique and context-specific values that engineers and technology developers need to explore, discuss and ethically reflect upon (Miller 2021). The design focus should always lie on the contextually relevant values that are important to the stakeholders affected (Pommeranz et al., 2012). To avoid the practical risk of projecting values top-down onto empirical cases, scholars have stressed that values need to be discovered within the specific context given (Boenink and Kudina 2020; Le Dantec, Poole, and Wyche 2009).

Such a bottom-up value discovery process can help to overcome the narrow and one-sided focus on commonly accepted "central" values and unveil context-specific "marginal cases" (Agre 1997, p. 45). Shifting the focus away from central themes to the marginal areas of a technology project "generates a more complete spectrum of relevant system requirements that lie out of today's corporate mainstream thinking" (Spiekermann 2016, p. 182). To illustrate this, Spiekermann discusses the example of a digital travel agent, where the marginalized concept of *gaining* time represented user needs and preferences much better than the mainstream value of *saving* time or efficiency, values which are much more easily accessible for designers engaged in a design task. In line with this, Stolterman (2008) formulates the requirement that "methods and approaches aimed at improving design practice have to be designed with a sincere respect and understanding of the positive aspects of the complexity and richness of the particular qualities of the case at hand" and continues that "the only way to keep that richness is for the designer to be fully immersed in the context of the case and to make sense of that context based on an understanding of the particular situation" (p. 61).

Apart from this, a list does not provide a solution for the selection of the most relevant values that need to be taken into account for a specific technology and its use context. Human values need to be discussed in detail to explore different contexts, interpretations and nuances (Steen & van de Poel, 2012). Building on rich and versatile value knowledge helps not only in communicating values (Pommeranz et al., 2012), but also in understanding their true meaning. For example, considering "freedom from harms" as a general definition of security does not provide enough information on what specifications or requirements a product needs to fulfil. Security could refer to the protection of private data using encryption as well as to the protection of a private estate using video surveillance. This necessary level of detail for (context) information poses a challenge for the representation and communication of values during the development of a technical product. Especially in the field of transformative technologies such as nano- or biotechnology, there is an increased need for more flexible ways of moral deliberation (Umbrello, 2020b). Therefore, the acknowledgement of the context-specificity of values has formed a key characteristic of value-oriented projects, which usually start with the identification of values within a specific technology design context.

2.3.2. Bottom-up Challenges: Value Identification in Need of Ethical Commitment

Applying VSD can avoid problems which predefined lists of values are confronted with. By relating values to harms and benefits associated with a specific technology, a specific context of use, and the directly and indirectly affected stakeholders (Friedman et al., 2006), the identified values will most likely represent both beneficial and adverse effects of the technology and go beyond traditional or "mainstream" values with a technical and economic focus.

The VSD methodology is iterative and integrates conceptual, empirical, and technical investigations (Friedman & Hendry, 2019; Friedman et al., 2006, 2013). When applying VSD, Friedman et al. (2006) suggest to start with a value, technology or context of use, depending on the project's most central aspect. With this in mind, direct and indirect stakeholders are determined in *conceptual* investigations, where the question how they are affected by the design is also clarified (Friedman et al., 2013). In the next step, corresponding values, which ideally go hand in hand with organizational goals, are determined and conceptualized by turning to the relevant literature, e.g., from philosophy (Friedman et al., 2006). Also, trade-offs among competing moral and non-moral values can be discussed. *Empirical* investigations focus on the social context in which a particular design is situated and clarify, e.g., how stakeholders apprehend and prioritize particular values or what an organizations' motivations are (Friedman et al., 2006). For this purpose, VSD has explored and established a variety of qualitative and quantitative social science research methods such as semi-structured interviews (Friedman et al., 2017). *Technical* investigations, in contrast, focus on the technology itself and on how a system can be proactively designed to support particular identified values or to address value conflicts and trade-offs (Friedman et al., 2013).

The tripartite VSD methodology should be applied iteratively to proactively address the design of technology early in and throughout the design process (Friedman & Hendry, 2019; Friedman et al., 2006, 2013). Yet, the order of investigations is highly relevant. VSD has been criticized for imposing values on a context instead of eliciting values from it (Le Dantec et al., 2009; Reijers, 2018). Underlying this criticism is the claim that technology design should incorporate the values that are important to the people who are affected by the technology rather than previously identified values with moral import, which VSD scholars have (also) presented (e.g., Friedman et al., 2006). Le Dantec et al. (2009) argue:

> By identifying with a set of values imbued with the gravitas of being ethically grounded, and advocating a value-sensitive design methodology whose first step is a conceptual investigation of values rather than an empirical discovery of values, it becomes easier to fall back on the set of ethical values for conceptual investigation rather than engage in discovery and discourse about values within the context of design. (p. 1144)

They conclude that the empirical VSD phase should thus receive more attention and include the *discovery* of values at the beginning of the investigation (Le Dantec et al., 2009). To counter this criticism, VSD can point to the various empirical value elicitation methods (e.g., stakeholder-generated value scenarios or value sketches), which support the bottom-up elicitation of values and focus on the immediate context of use of a technology (Friedman, Hendry, and Borning 2017). However, eliciting values for a specific technology use context resorts to the "dilemma of distinguishing between 'moral values' and mere preferences" (Reijers, 2018, p. 5). VSD scholars have emphasized that they include "all values, especially those with moral import" (Friedman et al., 2006, p. 360) and that VSD aims at "integrating ethics and sociotechnical analyses with actual design" (Friedman and Kahn, Jr. 2003, p. 1186).

Yet, as Reijers and Gordijn (2019) argue, this is difficult for VSD approaches to achieve through a mere empirical value discovery without a foundation in normative ethics:

> …the approach either departs from an investigation of stakeholder preferences, which leads to an underdeveloped notion of value as a mere preference or from a fixed list of values that leads to an arbitrary and potentially dogmatic heuristic. We argue that this is largely the case because VSD does not engage with theories in normative ethics. Such theories are responsive to what people find valuable in life, but at the same time ground judgment concerning value (e.g. on what ought to be done or what ought to be considered valuable) on a normative theory. For instance, hedonist utilitarianism might support "privacy" as something that people find important in life, and simultaneously provide an account concerning why privacy ought to be valued (e.g. because of the pleasure one derives from non-interference in intimate situations). (p. 199)

The ethical grounding of the values that are acknowledged in the design of technology is a key issue that needs to be addressed by any value-oriented design method. Values may represent what is important to people, but this does not necessarily imply a moral basis. For example, users of information systems might value comfort, but designing systems accordingly could have harmful effects for the users' health, and, by encouraging ongoing use of the product, could even draw on energy resources and thus negatively impact the environment. This problem is often referred to as Hume's law: one cannot move from *is* to *ought* (Hume, 1777), i.e., deduce ethical acceptability from preferences of people (Stahl et al., 2014). While Friedman et al. (2006) are aware of this problem and have addressed the naturalistic fallacy themselves, their conclusion is that "values cannot be motivated only by an empirical account of the external world, but depend substantively on the interests and desires of human beings within a cultural milieu" (p. 349). This response is at the least vague and does not provide a clear solution for how a conflation of facts and values can be avoided, resulting in the criticism it sought to avoid: "VSD runs the risk of committing the naturalistic fallacy when using empirical knowledge for implementing values in design" (Manders-Huits, 2011, p. 284).

To ensure that a value elicitation process actually leads participants to identify higher, morally relevant values, scholars have proposed to set up a moment of ethical reflection and commitment (Jacobs & Huldtgren, 2021; Reijers & Gordijn, 2019; Shiell, Hawe, & Seymour, 1997) or *philosophical mode* (Flanagan et al., 2008). Wallach and Vallor (2020) define critical moral reflection as "the ability to stand back and critically evaluate one's own moral outlook, and that of others, from the moral point of view itself, that is, the capacity to form second-order normative evaluations of existing moral values, desires, rules, and reasons" (p. 392). This does not only show the fundamental importance of ethics for our human lives and actions, but also provides a necessary condition for taking a moral stance or, in the present context, identifying values with moral import. Manders-Huits (2011) has addressed the problem of how to deal with competing values and argues that a design approach based on values should be complemented by an explicit ethical theory that provides a moral basis for such decisions. Similarly, Shilton (2018) has argued that ethical frameworks "can help us make decisions between competing values and recognize values that advance human flourishing" (p. 129).

2.4 Candidates for Providing an Ethical Foundation for Values

In order to uphold an ethical conception of values rather than a sociological conception of values, the integration of ethical theory and analysis is required (Manders-Huits, 2011). Value theory and normative theories of ethics can inform one another. For example, the fact that Scheler derives a moral ought-to-do from a person's value-apprehension qualifies him as deontologist (Drummond & Timmons, 2023). The other way around, normative theorists such as Mill can be reduced to value theories when, with regard to Mill's theory, happiness is interpreted as the only intrinsic value that should be maximized (Schroeder, 2023).

In this thesis, I argue that we can borrow the core reasoning from ethical theories to justify that an identified value is indeed ethically grounded. Top-down ethical approaches have been criticized for being "indeterminate" because they are based on abstract principles which make it difficult to apply them to particular cases (Jacobs & Huldtgren, 2021, p. 25). This might hold true for a traditional analysis of an ethically relevant problem that should result in a concrete moral judgment or solution. However, the concept of values is inherently pluralistic and can profit from an ethical reflection based on abstract principles that at the same time allow for creative thinking. Thus, traditional top-down ethical approaches are good candidates for supporting ethical reflection in the value elicitation phase and grounding value-oriented design in ethical theory. Still, as argued in Section 1.2.1 above, the question "How do the Perspectives of Different Ethical Theories Influence Value-based Thinking in Technology Design?" (RQ1) has yet to be answered.

VSD scholars have discussed the moral reasoning underlying VSD in one of the earlier papers, where they assessed utilitarianism, deontology and virtue ethics as overarching moral theories (Friedman & Kahn, Jr., 2003). However, a specific underlying ethical framework for VSD has never been specified. Recently, VSD scholars have come to the conclusion that implications for technology use depend on the respective ethical perspective taken, leaving it up to the people involved in the design process to determine what makes a value *moral* (Friedman & Hendry, 2019). While such an open view avoids criticism for choosing one moral theory or approach over another, it also ignores disagreements among historic and contemporary theoretical perspectives. This is problematic, as ethical theories all propose different justifications for the good and right and exhibit unique advantages and problems. For example, utilitarianism seeks the highest utility in resulting consequences, deontology high universalism of moral principles and virtue ethics the golden mean in character traits. This has resulted in an ongoing discourse on the unique contributions of the theories that have developed over time in the field of ethics. Still, consequentialism, deontology, and virtue ethics are often considered the "big three" theories of ethics (Stahl et al., 2014). What is more, they form the ethical basis of value-based design and VBE (Spiekermann, 2016, 2023). I address RQ1 by exploring whether these three normative theories could provide an ethical framework for the elicitation of values by contributing a moment of ethical reflection, e.g., by asking what values relate to the beneficial or adverse consequences that could arise from the widespread use of a technology. This links the evaluation of values to the core ethical principles utility (utilitarianism), duty (deontology), and the golden mean (virtue ethics).

In the following, I briefly review utilitarianism (Section 2.4.1), deontology (Section 2.4.2), and virtue ethics (Section 2.4.3), examine their specific advantages and the challenges they face and discuss how they relate to values. In Section 2.4.4, I discuss how their joint application in a concrete setting such as the elicitation of values for a concrete technology context could play out and formulate specific research questions for RQ1.

2.4.1. Utilitarianism: Weighing Beneficial Against Harmful Consequences

Consequentialist theories provide a strong and simple reasoning for the evaluation of actions by considering their consequences and supporting actions that maximize good outcomes. Consequentialism "holds that we have reason to do what has or brings about value, that we should increase the amount of value in the world or even should maximize it" (van de Poel & Kroes, 2014, p. 108). *Utilitarianism* is a specific form of consequentialism that seeks to maximize the general good for the greatest number of people (Frankena, 1973). The utilitarians Jeremy Bentham (1748–1832) and John Stuart Mill (1806–1873) interpreted this good in psychological terms as pleasure, social utility, or well-being (Mill 1879/2009; Bentham 1789/1907), which can all be considered important values. This interpretation provides a strong reasoning for the evaluation of what is morally right. What is more, people from diverse backgrounds can agree on wanting to maximize a specific good for a large number of people without needing to specify underlying philosophical principles, which might differ in different cultures (Kibert, Monroe, Peterson, Plate, & Thiele, 2012).

For people with a business background, the core reasoning of consequentialism and specifically utilitarianism is easy to comprehend as it has heavily influenced basic economic principles. An *analysis of costs and benefits* (Drèze & Stern, 1987) weighs the expected costs of a decision, project, or product against the expected value that results for all stakeholders affected—and is usually based on monetary values. The *maximization principle* forms the core concept of neoclassical economics; it states that a firm foremost tries to maximize its profit, which, in its simplest form, results from subtracting total costs from total revenues. Other fields of study that focus on technology research and reflection also make use of an essentially consequentialist approach. For example, technology assessment, ethics of science and technology, and science and technology studies (STS) typically try to "*anticipate* the implications of scientific and technological advances and to *assess* the results of the anticipations with respect to social desires, political goals and ethical values" (Grunwald, 2017, p. 140). With this focus on implications and results, they essentially follow a consequentialist approach when assessing technologies (Grunwald, 2017). VSD projects follow a similar approach (Friedman et al., 2017) by brainstorming on potential stakeholder harms and benefits and mapping them onto corresponding values (e.g., Rector et al., 2015).

Just as there are many possible actions that can maximize the general good, i.e., the highest value to be pursued, there could be different values related to technologic capabilities that support this general good. Thus, a consequentialist perspective can lead to the identification of relevant values such as human health and environment (Doorn, 2012). However, Scheler would disagree that a normative theory could contribute an ethical framework for the concept of values. He even explicitly rejected utility as a foundation for moral values when he stated that "usefulness and harmfulness … do not function in the least as … the factor that determines the unity of the values as 'moral' or 'immoral'" (p. 178). Yet, he continued, "utilitarianism thinks it has given us a theory of good and evil *itself*; but in fact it has only given us a (true) theory of the *social praise and disapproval* of good and bad, and therein lies its error" (p. 178). One could argue that we can take this "true theory of the social praise and disapproval of good and bad" to elicit moral values. However, the emphasis of possible consequences, e.g., the implications of a technological capability, also raises issues. Several arguments have been presented against consequentialist theories. I want to discuss three main challenges of utilitarian and consequentialist theories.

First, for consequentialists, a morally required action is one that maximizes "the good". Consequentialist theories thus require a definition of the good before they can determine what is right. This core assumption is often seen as problematic. In order to make something comparable, it is necessary to find a common denominator. In economics and business, monetary values in any currency act as such a common feature. However, the fact that "value" in the economic context is usually understood in monetary terms ignores that "many of the things we most value are not for sale" (Raworth, 2017, p. 35). Philosophers have argued for different scales with which consequences should be measured. For utilitarians such as John Stuart Mill (1806-1873), the good that should be maximized is *utility*, which is usually further defined in terms of well-being, pleasure, or happiness. Thus, utility or well-being could be seen as the highest value from the utilitarian perspective (Brey, 2015). But it is not only difficult to estimate the "value" that results from the consequences of a decision, a project, or a value. In order to determine the best option, it is also necessary, and the more challenging, to find a way to compare available options.

Second, it is immensely difficult if not impossible to assess all possible alternative actions and all possible consequences following from these actions. Considering that it is generally difficult for humans to consider the set of possible consequences, this challenge risks to overthrow the merits of what seems to be a simple reasoning for the evaluation of actions at first glance. Messick and Bazerman (2001) point out that decision-makers tend to "reduce the set of possible consequences or outcomes to make the decision manageable", and make decisions "solely on the basis of the one privileged feature" (p. 10). What is more, biases tend to restrict the consideration of consequences to the close future and the most visible stakeholders, which ignores other affected groups of people including those affected through collective consequences (e.g., when an action affects a firm and not just an employee) as well as the public in general, but also consequences with a lower probability (Messick & Bazerman, 2001).

Third, the maximization principle always evaluates an action weighed against its alternatives, which leads to the justification of actions that cause harms. For example, causing the death of one person could be justified for the sake of saving two lives. James H. Moor put this argument as "good ends somehow blind us to the injustice of the means" (Moor, 1999, p. 68). An example for where this becomes relevant in technology design is the Moral Machine experiment[3] conducted at MIT. In this experiment, participants weigh the benefits and costs of an autonomous car killing some pedestrians at the expense of others in an unavoidable accident, depending on their worth to society, the economy, etc. (Awad et al., 2018). This *utilitarian*

[3] https://www.moralmachine.net/

calculus is contrasted with the deontological position that optimizing decisions on who is supposed to die through maximizing economic or other societal principles can never justify the breach of moral principles such as human dignity and equality. This can be mitigated by a form of *general utilitarianism*, which does not focus only on the consequences of one particular person and her action in a specific situation (as is the case for *act utilitarianism*), or the consequences of adhering to a particular rule (*rule utilitarianism*), but considers "what would happen if everyone were to do so and so in such cases?" (Frankena, 1973, p. 37).

To sum up, the consequentialist approach is easy to comprehend as it is based on an analysis of expected outcomes, which is intuitive not just to economists and business people but also to any layperson. However, when it comes to comparing the outcomes, the theories meet challenges both in the fields of philosophy and economics that deontological theories can avoid altogether.

2.4.2. Deontology: Addressing Moral Obligations

While consequentialist theories such as utilitarianism focus on the outcomes of an act, deontological theories put the emphasis on duty, as *deon*, the Greek word for duty, implies. *Deontology* emphasizes that it is not the consequences that determine what is morally good and right but the good will of a person (Kant, 1785/2011). From a deontological perspective, a moral agent has to consider the universal moral laws inherent in an action and follow moral principles "from duty" (Kant, 1785/2011, p. 23). An example would be fulfilling a promise, which we consider right, not because of the consequences that might follow, but because of its adherence to the underlying moral obligation (Ross, 1930). For Kant (1785/2011), moral obligations are grounded in the categorical imperative "act only according to that maxim by which you can at the same time will that it should become a universal law" (p. 71), to which he added that the outcome of an action can never justify the action itself. This core principle is completely antagonistic to what consequentialism claims. It also gives rise to Kant's formulation of the practical imperative: "So act that you use humanity, in your own person as well as in the person of any other, always at the same time as an end, never merely as a means" (p. 87).

The deontological perspective usually avoids the danger of justifying acts that we would intuitively judge as bad or wrong. Acting out of duty can never promote actions that are in themselves harmful, such as killing a person. The deontological focus on a person's moral obligations also allows for more flexibility regarding personal ties, as duties are dependent on a person's roles and sphere of action (Ross, 1930). For example, a teacher has a special obligation to support his students in their personal development, and a doctor is obliged to serve her patients well, but these duties do not necessarily extend to other people. What is more, deontology avoids an overwhelming complexity in the assessment of a morally good action, as (according to Kant, 1785/2011) any rational agent is capable of recognizing moral laws or maxims.

Research suggests that our moral understanding is grounded in the underlying philosophical reasoning of deontology. Not only has deontological thinking been associated with basic social-emotional responses (Greene, Nystrom, Engell, Darley, & Cohen, 2004), but also shapes the most common moral reasoning. Latta and Dugan (2019) found that student participants applied Kant's categorical imperative most frequently (followed by utilitarianism) when selecting ethical principles for different situations. Duties also represent a common instrument of moral guidance in the corporate context, e.g., in the form of professionals' codes of ethics. For example, the "ACM Code of Ethics and Professional Conduct" (2018) includes a list of general ethical principles which a computing professional should adhere to, among which the first two claim that a computing professional should "contribute to society and to human well-being, acknowledging that all people are stakeholders in computing" and "avoid harm". A deontological perspective can also help to uncover values in technology design that moral agents should seek to protect. For example, Friedman and Kahn (2003) have argued that privacy can be derived as a value that is harmed because of vendors' unconsented data collection, which is to be considered an immoral action from a deontological perspective. Scanlon (1998) has presented a similar argument based on a modified version of the categorical imperative, which, in brief, stresses that it is the "*desire* to act in a way that can be justified to others" (p. 7) that motivates "the good" in values.

Still, deontological theory faces several difficulties. First, the deontological focus on universal principles can be difficult to apply to concrete situations. A major challenge is how deontology should deal with the tension between alternative moral duties that seem equally important but imply different actions to be taken (Alexander & Moore, 2020). Especially in its Kantian absolutist version that puts the morally good above anything else, deontology provokes absurd situations where one is obliged to adhere to a moral rule (such as saying the truth) although it will unequivocally cause harms. Consider, for example, disclosing the identity of people that are in the danger of being killed by a political regime because of their ethnicity. Ironically, deontological theories can deal with such issues by incorporating seemingly consequentialist elements, such as considering "the tendency of acts to promote the general good" (Ross, 1930, p. 39). Still, deontologists try to formulate such duties without resorting to a general consequentialist reasoning. In this way, deontology and utilitarianism can complement each other (Brady & Dunn, 1995).

Second, Scheler (1913-1916/1973) criticized Kant for overemphasizing duty. For Scheler, the person was more important than any principle: "For Kant, a being X is a person only through its performing a non-personal rational activity—above all, an activity of practical reason; thus the value of the person is determined by the value of the will, and not the value of the will by the value of the person" (p. 28). This argument targets the core idea of deontology that the will of a person makes an action morally right or wrong. In contrast, Scheler continued to argue that duties can only inform moral decisions in so far as they relate to values. Kant's grounding of duties in one foundational principle, the categorical imperative, was also criticized by Ross (1930), who instead proposed a deontological pluralism, maintaining that the rightness of an action depended on the adherence to different groups of duties. These *prima facie* duties comprised duties of fidelity, duties of reparation, duties of gratitude, duties of justice, duties of beneficence, duties of self-improvement, and duties non-maleficence (p. 21), from which other duties such as honesty can be derived.

Another danger inherent in applying Kant's philosophy was famously portrayed by Hannah Arendt's (1965/2006) documentation of the Eichmann trial in Jerusalem, where Adolf Eichmann proclaimed that he did not feel guilty because he had acted in accordance with Kantian principles. Eichmann's error was to uncritically embrace the evil principle of Arianism, because he took the ideology of his time to be a morally valid universal law. In the current business and technology environment, principles such as profit, innovation, or growth could also mistakenly be considered as ethically desirable principles solely because they represent the current corporate norm. This problem relates to Agre's (1997) critical discussion of technology discourses that only focus on central themes, which Spiekermann (2016) has taken up in her discussion of mainstream values.

2.4.3. Virtue Ethics: Supporting Good Character Traits

Next to the action-centered focus of consequentialism and deontology, there are approaches that put their foci differently. Among these, virtue ethics is one of the oldest and most prominent theories that emphasize the moral excellence of a person's character rather than her adherence to rules of action, duties, or resulting consequences. Virtues constitute the fundamental element in virtue ethics. Virtues can be defined as "a disposition, habit, quality, or trait of the person or soul, which an individual either has or seeks to have" (Frankena, 1973, p. 64). They represent "a balance between excess and deficiency," where any set of values is in balance with an individual's social context (van Staveren 2007, p. 27). Virtues are bound to the character and behaviour of individuals, but at the same time bear relevance to the moral thriving of a community at large. When I refer to "values" in the following, I also include virtues as moral values carried by a person (Kelly, 2011). In this sense, virtues are values with moral relevance for both the personal development of the person (consider, e.g., excellence) and the social interactions of the person (consider, e.g., honesty). Thus, virtues can help to emphasize the importance of society and social practices instead of only focusing on the individual in moral questions (MacIntyre 1981/2007).

One of the earliest and best-known proponents of virtue ethics is Aristotle (384-322 BC), who defined concepts that are still key to theories in virtue ethics today. In his *Nicomachean Ethics*, Aristotle (2004) described virtues such as courage, temperance, patience, friendliness, justice, and modesty along with the virtue of practical wisdom *phronēsis,* which supports a virtuous person in doing the right thing. A virtuous person does the right things not only because they are considered to be right. Rather, true virtue shows itself in a person acting and feeling a certain way because of the nature of her character. A virtuous person will tell the truth, not because she has to, because it leads to the best outcomes, or because she wants to adhere to the moral law that you should always tell the truth, but because she *is* a truly honest person and wants to lead a morally good life. Therefore, virtues do not only lead to morally good actions, but characterize a good person. Most importantly, according to Aristotle (2004) only a truly virtuous person can live in true happiness or *eudaimonia*.

In the Western world, virtue ethics played a subordinate role for much of the 19th and 20th centuries (Vallor, 2016). However, it has recently shown great potential in dealing with the ethical issues posed by new developments. For example, MacIntyre (1981/2007) revives virtue ethics to address the moral crisis of modernity and discussed courage, justice, temperance, prudence, hope and faith as key virtues. Shannon Vallor (2016) argues that virtues can help us to evaluate what technological developments, e.g., in the field of human enhancement, we should pursue, and, in turn, that virtues should be supported through technological means. She presents honesty, self-control, humility, justice, courage, empathy, care, civility, flexibility, (moral) perspective, magnanimity and technomoral wisdom as the twelve technomoral virtues that she sees as particularly important for dealing with the "increasing global complexity, instability, plurality, interdependence, rapid change, and growing opacity of our technosocial future" (Vallor, 2016, p. 245). While these virtues are universally important in dealing with current and future challenges of technological development, Vallor (2012) also presents a more context-specific virtue-ethical analysis of friendship on social media.

Including virtue-ethical considerations in a technology design process can help to capture the implications of a technology for the personal development of individuals interacting with such a technology (Ihde & Malafouris, 2019; Verbeek, 2006). Friedman and Kahn Jr. (2003, p. 1181) also recognize that specific values such as friendliness, caring, or compassion "fit within a virtue orientation". Thus, an ethical technology design framework should capture not only values but also virtues. A virtue ethics perspective is important for managing the technoscientific impact in our society wisely. It is not surprising then that virtues have also found their way into the business and management literature (Nonaka & Takeuchi, 2011), which suggests that "wise leaders" should recognize the essence of a situation with practical wisdom (*phronesis*) to make judgments for the common good. Focusing on the concept of virtue in technology design and innovation process can furthermore support business people and engineers to consider the moral development of affected stakeholders, who they might otherwise only see as "users," "human resources," or "consumers." This aspect has increasingly come to the fore of critical technology discussion and the concern about the degradation and symbolic impoverishment of humanity (Stiegler, 2019).

Virtue ethics shares issues with deontology such as the question on how to deal with two apparently contradicting virtues in a specific situation, but it has also been criticized for its unique focus on the person's character, which does not offer straightforward guidance on morally good actions, e.g., through moral guidelines or universal principles (Hursthouse & Pettigrove, 2022). Virtue ethicists such as Vallor (2016) would argue that this apparent weak point of virtue ethics is also one of its strengths: good character traits are flexible in responding to new challenges in our everyday routines, which a pre-established set of rules is less apt to do. This idea has been taken up by Reijers and Gordijn (2019), who propose a virtuous practice design, which focuses on practices in relation to the technology and the various stakeholders and tries to discover ways in which a technology supports or obstructs the cultivation of virtues, thus including considerations of human development. In line with this, it has been argued that it is important to consider a virtue-based approach next to the established VSD methods (Umbrello, 2020a).

Virtue ethics is especially relevant for emphasizing individual growth and personal development and acknowledging the intersection of individual and social values. Against this background, the integration of a virtue ethics perspective in value-oriented research might be especially suited to complementing a bottom-up elicitation process of values and virtues relevant for a specific technology.

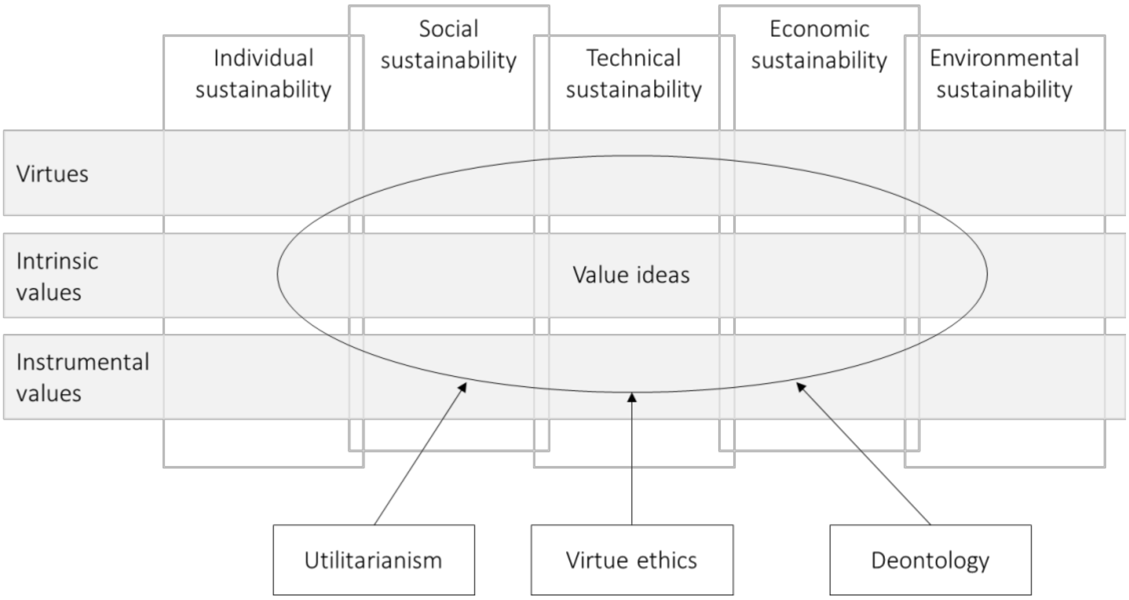
2.4.4. Comparing Ethical Perspectives on Values

In order to address the shortcomings of existing value-oriented methods discussed in Section 2.3.2 "Bottom-up Challenges: Value Identification in Need of Ethical Commitment", I apply an ethical framework based on three prominent theories of moral philosophy to uncover the value potentials of an IT product: utilitarianism, virtue ethics and deontology. As discussed above in Section 1.2.1, these theories differ significantly in the way they derive what is good and right and thus stand in competition. At the same time, the reasoning of one ethical perspective could complement the reasoning of another perspective in a practical and creative setting(Brady & Dunn, 1995). To answer RQ1 "How do the Perspectives of Different Ethical Theories Influence Value-based Thinking in Technology Design?", I will first look at the particular values that come up frequently in a value elicitation process that is inspired by a utilitarian, deontological, or virtue ethics perspective, respectively. I capture this research aim in the following specific research question.

- **Research question 1.1:** Which particular values does a utilitarian, deontological, and virtue ethics perspective inspire participants to identify?

In Section 2.2.4, "Intrinsic/Instrumental Values and Virtues", I have argued that value ideas resulting from an ethically inspired reflection and value elicitation process could be evaluated by looking at different types of values that they represent. Figure 4 combines the ethics-based value elicitation process from the perspectives of utilitarianism, virtue ethics, and deontology with the value framework that I have proposed so far to describe and explore RQ1 and resulting value ideas.

Figure 4. Ethics-based value elicitation and resulting value framework (RQ1)



Note. In this figure only neighbouring sustainability dimensions are portrayed as overlapping. However, sustainability dimensions can theoretically overlap in all possible combinations (Penzenstadler & Femmer, 2013; Winkler & Spiekermann, 2019).

I want to investigate to what extent the three ethical perspectives utilitarianism, deontology, and virtue ethics can elicit instrumental and intrinsic values as well as virtues and what dimensions of sustainability they cover, resulting in different value groups. From this, I derive the following two specific research questions.

- **Research question 1.2:** What share of intrinsic/instrumental values and virtues does a utilitarian, deontological, and virtue ethics perspective inspire participants to identify?
- **Research question 1.3:** What underlying sustainability dimensions (value classes) does a utilitarian, deontological, and virtue ethics perspective inspire participants to identify?

2.5 Bringing Values to IT Innovation Practices

Based on the two aspects addressed in Section 1.2.2 "Value-based Idea Generation and Technology Roadmapping" and Section 1.2.3 "Value-based Idea Evaluation and Decision-Making", I now turn to two important phases in the innovation process: technology roadmaps and investment decisions. Technology roadmaps are based on ideas from the idea generation phase that enter the further innovation process. Later in the process, investment decisions evaluate ideas to decide over the fate of an IT product or service.

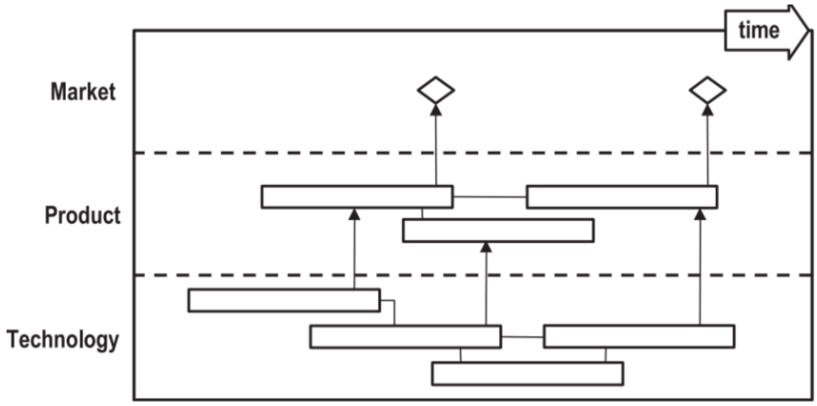
In the following, I briefly introduce technology roadmapping (Section 2.5.1) and investment decision-making strategies (Section 2.5.3) in the innovation process. Based on the idea that an ethics-based focus on values could complement traditional practices, I formulate specific research sub-questions for RQ2 “How Do Ideas Generated by a Value-based Approach Compare to Ideas Captured in Traditional Technology Roadmapping?” (Section 2.5.2) and for RQ3 “How Does Value-Based Thinking Influence IT Investment Decisions?” (Section 2.5.4).

2.5.1. Technology Roadmapping

A company that tries to extend its products and services with the help of IT often develops a technology roadmap to plan what it wants to design and develop over time. Technology roadmaps are strategic innovation tools that help companies with their long-term planning and foresight activities (Kerr & Phaal, 2020) by acknowledging the market (customer needs and competition) and anticipated technical novelties (de Alcantara & Martens, 2019; Vinayavekhin et al., 2021). Roadmapping practices aim “to develop, represent and communicate strategic plans, in terms of the coevolution and development of technology, products and markets” (Phaal, Farrukh, & Probert, 2004, p. 10), using visualizations as shown in Figure 5.

Roadmapping goes back to the 1960s (Vinayavekhin et al., 2021) and is rooted in industry practice (Kerr & Phaal, 2020). Roadmapping practices have been widely researched (de Alcantara & Martens, 2019) with more than 500 publications as of June 2020 and an overall upward trend (Vinayavekhin et al., 2021). There are various types of technology roadmaps, which put different factors into focus by using different visualization formats (Phaal et al., 2004). For example, roadmaps can be visualized with multiple layers, bars, trees or flow charts (Phaal et al., 2004). The represented layers can include products and technologies for product planning or focus solely on long-term technology developments or other purposes such as process or program planning (Phaal et al., 2004). Current roadmapping approaches have been extended to deal with uncertainty in technology innovation (Lee, Jang, Lee, & Shin, 2021) and to manage agile processes (O’Sullivan et al., 2021).

Figure 5. Schematic technology roadmap (Phaal, Farrukh, & Probert, 2004, p. 10)



What most roadmaps have in common is a time-based structure and a graphical framework (Phaal et al., 2004) that shows timeframes on the horizontal axis and several layers and sub-layers on the vertical axis (Phaal & Muller, 2009). At the core of a typical technology roadmap is a constantly updated technical dashboard that summarizes the product characteristics, functions and features that go into an existing product or service over time. With the help of industry forecasting, companies investigate which technologies might become relevant over time and anticipate how competitors will try to take advantage of them (Ahmed & Shepherd, 2012). Based on this analysis and their own technical maturity, they decide to invest in certain technologies that then determine the product and service characteristics in their roadmap. Once the list of technological features is determined, the company can plan R&D projects to develop the particular technologies (Fenwick, Daim, & Gerdsri, 2009).

In the example presented by Albright and Kappel (2003) and shown in Figure 6, the product drivers partially coincide with values. For example, ease of use can be considered a technical value that can only be supported by a technological product or service. Also, audio quality can be considered another technical value, while weight/size are mere product characteristics that do not directly relate to a value. This shows that values can already be found in traditional technology roadmaps. At the same time, it raises the question what a roadmap would look like if the focus on values was made explicit. Dissel et al. (2009) have developed a value roadmapping approach that wants to provide “support for understanding the actual value streams that a technology may or may not generate” (p. 47).

Figure 6. Example for a technology roadmap (Albright & Kappel, 2003, p. 37)

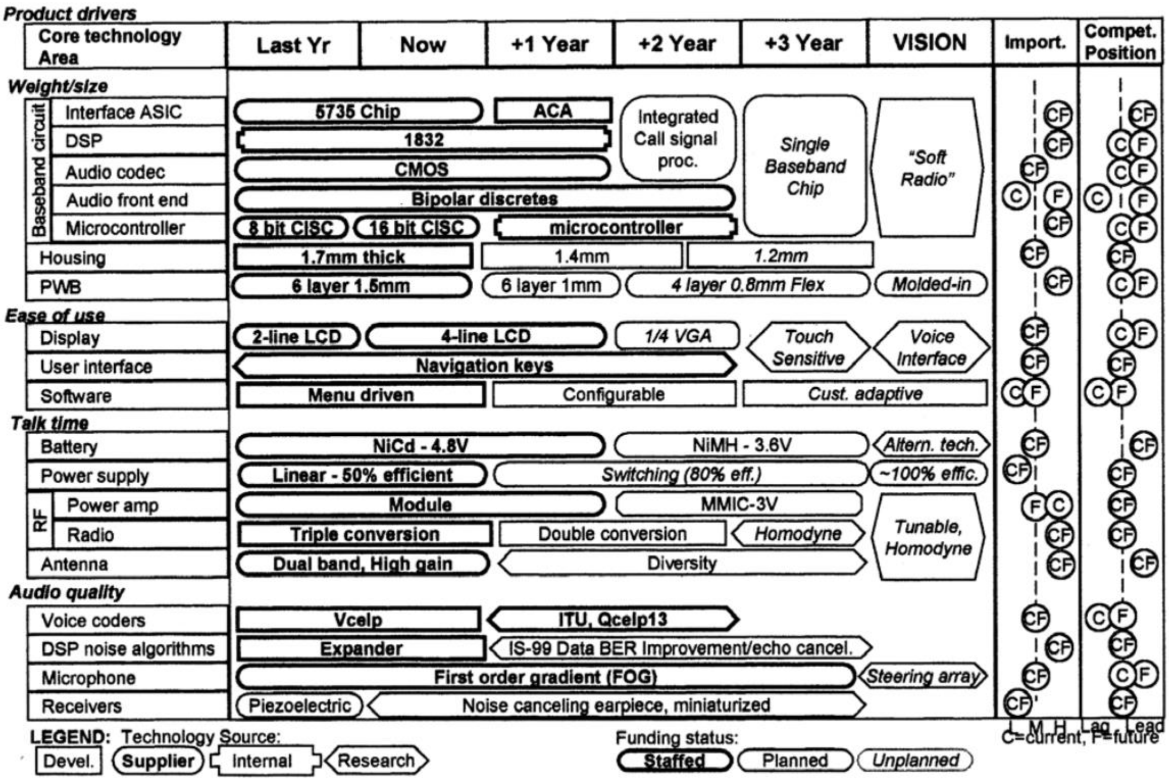
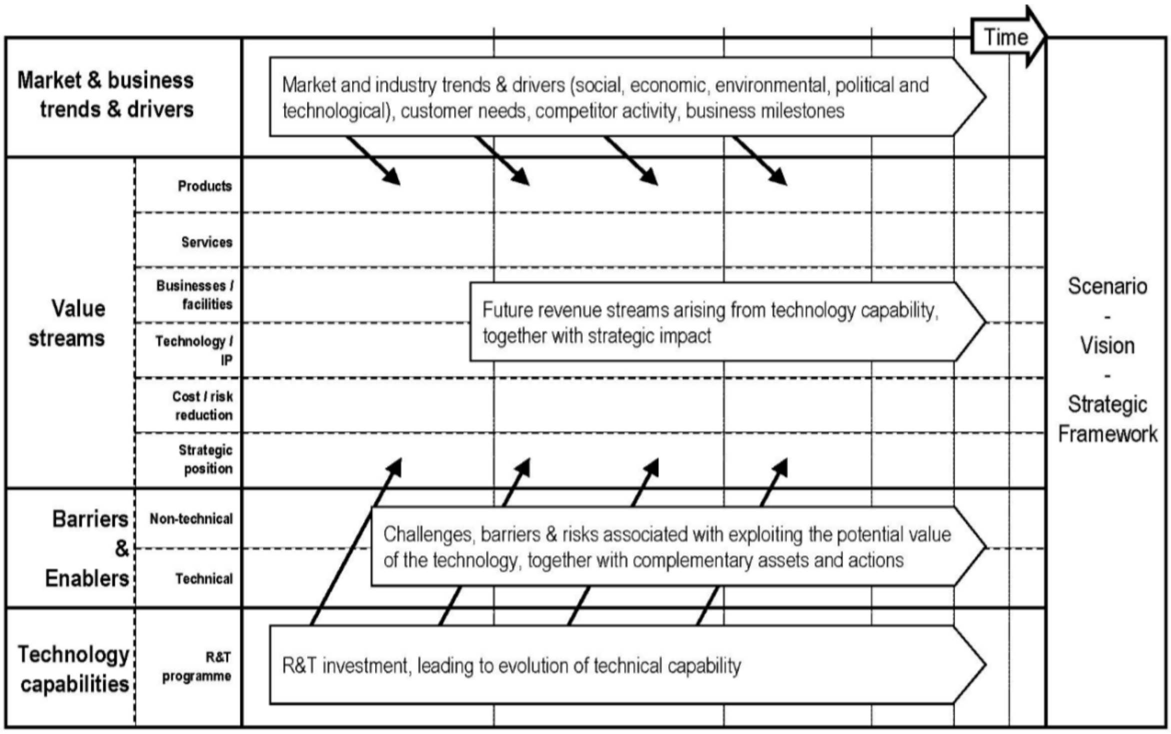


Figure 7 shows a schematic value roadmap as proposed by Dissel et al. (2009). This aim is in line with that of the thesis at hand. However, Dissel et al. (2009) do not fully recognize the benefit that the concept of values can bring to technology management. They understand "value" as a singular term, e.g., when they speak of estimating "revenue/value" or define value streams as "sources of future revenue and savings" which relate to the "generation of cash revenue" (p. 29). In contrast, the value-based approach presented in this thesis embraces a much broader understanding of values and seeks to establish an ethical context for the values that enter subsequent steps of the technology development process (as argued in Section 2.2.3 "Values Have Moral Import").

In addition, VRM does not fully address the criticism that traditional technology roadmapping has been confronted with. For example, traditional roadmapping does not meet current requirements such as a better consideration of the customers' needs and behaviours and higher flexibility in volatile environments (Münch, Trieflinger, & Lang, 2018). What is more, roadmaps focus on translating economic and technical values into product characteristics, assuming that technical features and efficiency satisfy customer expectations (de Alcantara & Martens, 2019; Vinayavekhin et al., 2021), leaving aside other values relevant for direct and indirect stakeholders (Friedman et al., 2006). Lastly, once the roadmap has been established, potential risks and adverse (value) effects of an innovation are no longer explicitly addressed and thus are more difficult to manage.

Figure 7. Schematic value roadmap (Dissel, Phaal, Farrukh, & Probert, 2006, p. 1491)



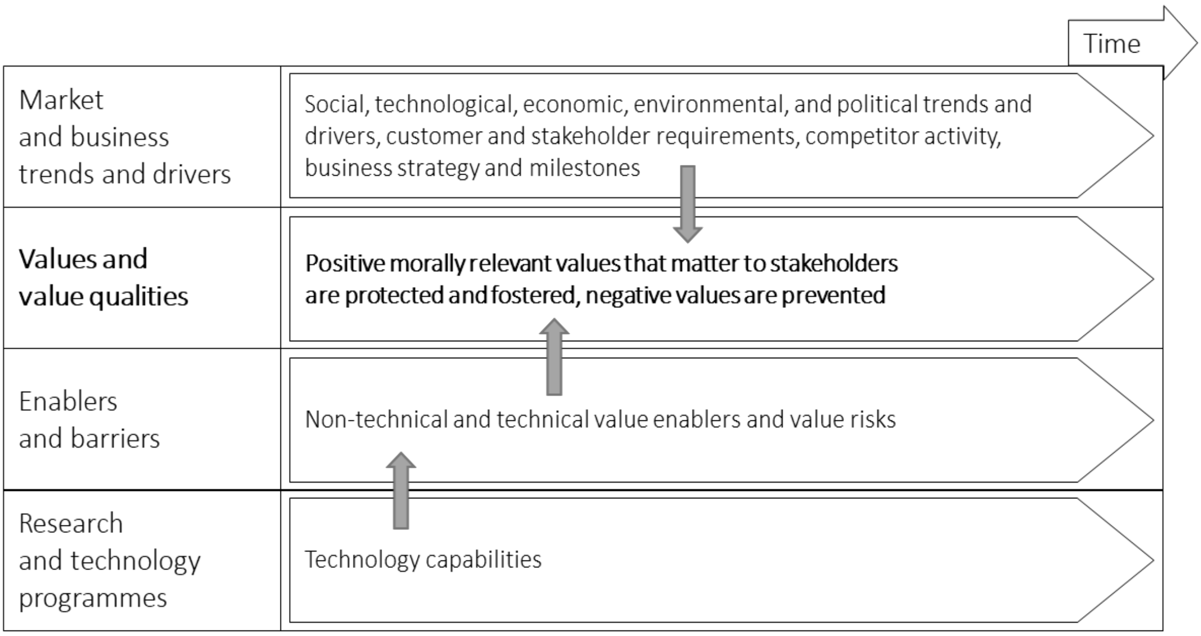
In this thesis, I want to explore whether an ethics-based value elicitation that results in a list of product characteristics, technical capabilities and related values can complement traditional roadmapping. A useful contribution to traditional technology roadmapping would be the identification of (additional) morally relevant values that should be acknowledged in the subsequent technology development process. Likewise, the acknowledgement of risks and the consideration of diverse stakeholders should also be achieved through an ethically oriented extension of roadmapping practices.

2.5.2. Traditional versus Value-based Roadmapping

Technology-based roadmapping has the potential to transition into *value-based* roadmapping when including important aspects of value-oriented approaches. Figure 8 shows what such an extended *value-based technology roadmap* could look like.

First, when the empirical and conceptual investigation of values (Friedman et al., 2013; Spiekermann, 2023) takes place before the roadmap has been drawn up and first prototypes have been developed, a variety of human and social values can be considered, which might inspire disruptive innovations (Spiekermann, 2023). Second, the concept of values has moral import and thus goes beyond the concept of needs, which drives, e.g., design thinking (Brown, 2009). This is vital, as all needs can be represented as values, but not all values can be captured by needs. Third, value-oriented approaches embrace indirect stakeholders (Friedman et al., 2013; Spiekermann, 2016), such as communities or society at large, and put a critical emphasis on potential negative consequences of IT products, which they envision in the long term and at at scale (e.g., with the use of *envisioning cards*, Friedman et al., 2017). In the following, I discuss likely benefits of an ethics-based approach in comparison to a traditional roadmapping approach in terms of anticipated effects on stakeholders and creative value output and formulate corresponding research questions.

Figure 8. Schematic value-based technology roadmap (adapted from Dissel, Phaal, Farrukh, & Probert, 2009, p. 48, and Dissel, Phaal, Farrukh, & Probert, 2006, p. 1491)



To account for the importance of creativity in the design and innovation context, I investigate to what extent the two approaches lead to different value ideas and compare the results. Research suggests that the identification of key restrictions and envisioning multiple different outcomes or alternative actions (“forecasting”; Harkrider et al., 2012, p. 261) contributes to creative problem solving (Osburn & Mumford, 2006).

Traditional roadmapping focuses on technology strategy and competitive advantage (Albright & Kappel, 2003; Cooper & Edgett, 2010; Pham et al., 2013). In an ethics-based approach, however, values are discovered by means of the three ethical perspectives of utilitarianism, virtue ethics, and deontology. From a philosophical perspective, utilitarianism, virtue ethics, and deontology differ significantly in their judgment of the good and right and it is disputed whether one theory has advantage over the others (see Section 1.2.1 “An Ethical Framework for Values” above). Still, their unique theoretical angles on the good and right could produce a variety of ideas on how human values are impacted by a specific technology, leading to a richer and more holistic understanding, as has been suggested for the combination of research methods (Mingers, 2001). The multiple ethical lenses are likely to lead to an increased ideational fluency for value ideas—that is, ideas that are strongly connected to a value or virtue or imply such a connection, by “discovering fresh or paradoxical factors” (Mingers, 2001, p. 244). I will use ideational fluency, i.e., the ability to come up with multiple responses in an open task (Guilford, 1971) to investigate the productivity of the two approaches in terms of the number of ideas elicited. This leads to the specific research question 2.1.

- **Research question 2.1 (Fluency):** To what extent can an ethics-based approach contribute to the identification of value ideas in technology roadmapping?

Whereas the traditional roadmap captures product ideas by considering technology strategy and competitive advantage (Albright & Kappel, 2003; Cooper & Edgett, 2010; Pham et al., 2013), an ethics-based approach investigates values from ethical perspectives and then deduces product characteristics from the identified values. One might expect that an innovation approach specializing in identifying product characteristics on a technical level such as roadmapping should take the lead on churning out specific ideas for the IT product’s design. However, the theoretical angles of the different ethical perspectives could produce complementary ideas on the impact a certain technology has on humans, which could also increase ideas for product characteristics, as they are derived from the value ideas identified through the multiple ethical perspectives. This is captured by research question 2.4.

- **Research question 2.2 (Fluency – Product ideas):** To what extent can an ethics-based approach contribute to the identification of product ideas in technology roadmapping?

In accordance with Guilford’s (1971) conceptualization of creativity as divergent thinking, I explore not only ideational fluency, but also the flexibility of thought and the originality of ideas. Flexibility refers to the production of ideas that go beyond thinking in fixed categories or classes (Guilford, 1966). Traditional innovation approaches understand values only as monetary benefits opposed to costs, or as an organization's unique business strategy (Pham et al., 2013). Even advancements of traditional roadmapping such as value roadmapping (Dissel et al., 2006) share this view of values in terms of "revenues" and "savings" and ignore human, social, or moral aspects. But this is too short-sighted. A wider understanding of values sees value harms when a plane is not safe, a car engine not environmentally friendly or a social network manipulative. Such threats depart from the reduced understanding of risks as *competitive threats*, which roadmaps can build upon (Kappel, 2001). Recent work (Winkler & Spiekermann, 2019) has classified values into *technical*, *economic*, *social*, *individual* and *environmental* values by linking them to five sustainability dimensions (Penzenstadler & Femmer, 2013). Here, the question arises whether a value-based approach based on ethical perspectives takes different sustainability dimensions into account, leading to the following specific research question.

- **Research question 2.3 (Flexibility):** To what extent can an ethics-based approach contribute to more flexible ideas covering several value classes in technology roadmapping?

Originality is a core aspect of creativity (Batey, 2012; Dean et al., 2006; Runco & Jaeger, 2012) that can be captured by rare ideas as opposed to common or mainstream ideas. In the present study, original value ideas should differ from the mainstream values that are typically found in ethical guidelines and are thus likely to be mentioned frequently. A good example for a mainstream value is privacy, as it relates to a wide area of research in the past years (Yun et al., 2019) and is often listed as an ethical principle that should be acknowledged in IT development (Jobin et al., 2019). Instead, original ideas signal thinking outside the box and existing frames of reference. They would thus target values that go beyond easily accessible concepts and focus on the unique specificity of a technology context. The originality of value ideas inspired by the ethics-based approach and the roadmapping inspires the last creativity-related specific research question.

- **Research question 2.4 (Originality):** To what extent can an ethics-based approach contribute to more original value ideas in technology roadmapping?

From a roadmapping perspective, companies want to create innovations for their customers, whose needs drive the roadmap (Albright & Kappel, 2003). Thus, when a negative impact on important values such as privacy or security becomes the subject of public discourse or an issue addressed by customers, a company's consideration of these issues might find its way into the roadmap. Still, it is questionable whether value issues beyond those that are much discussed in the media are recognized by a traditional technology roadmap. In contrast, value-oriented approaches such as VSD start from the identification of harms and benefits that could arise for stakeholders (Friedman et al., 2006) and VBE (Spiekermann, 2023) uses ethical theories to explicitly anticipate both positive and negative value potentials inherent in a new technology or technological innovation. From this, I derive the following specific research question on ethical sensitivity regarding potential adverse effects.

- **Research question 2.5 (Adverse effects):** To what extent can an ethics-based approach contribute to the identification of potential adverse effects in technology roadmapping?

Traditional roadmap approaches consider stakeholders in the planning process, but many of the approaches limit the group of stakeholders to direct customers (Albright & Kappel, 2003), company stakeholders (e.g., Cosner et al. 2007), or prominent stakeholders from industry, academia and the government (Jeffrey, Sedgwick, & Robinson, 2013). However, diverse groups of people, but also animals, nature and society at large may be affected by IT products in a direct or indirect way. Value-oriented approaches want to account for that by explicitly asking how the IT product that is to be designed or re-designed could affect both direct and indirect stakeholders (Friedman et al., 2006; Shilton, 2018; Spiekermann, 2023). Thus, ethical analyses in early phases of a value-based design and innovation process should detect implications of the IT product that are relevant for a broad range of stakeholders. From this, I derive the following specific research question on stakeholders.

- **Research question 2.6 (Stakeholders):** To what extent can an ethics-based approach contribute to the acknowledgment of stakeholders in technology roadmapping?

Considering that values are highly context-specific, it is difficult to estimate the effect of a specific form factor or context of use of a technology on the innovation process. This inspires the last specific research question in the comparison of traditional roadmapping and an ethics-based approach.

- **Research question 2.7 (IT products/services):** To what extent does the IT product/service under investigation influence the ideational output captured in an ethics-based versus traditional approach to technology roadmapping?

I explore this question empirically by comparing three different IT products and services.

2.5.3. IT Investment Decisions

Researchers as well as practitioners need to evaluate what risks and side effects might occur when an IT-based system comes into wider use. This is important from an ethical perspective, as technologies have the highest impact on society once they are in widespread use (Moor, 2005), as well as from a business perspective, as investing in a new technological product comes with risks and uncertainty (Pervaiz Ahmed & Shepherd, 2010). Firms with sufficient technological capability can pioneer an industry sector through radical innovation and thus enter the market early, while other firms acquire emerging technologies to make them successful on the market or focus on price-competitive products (Pervaiz Ahmed & Shepherd, 2010).

The Hype Cycle (Linden & Fenn, 2003) and diffusion models (Rogers, 1983) describe how difficult it is to anticipate the impact of new technological products on individuals and the society at large: a technological innovation is adopted over time, starting with a peak of inflated expectations (*hype*) and, ideally, continuing into the widespread use of the majority (*diffusion*). Yet, some products do not even make it to that stage because of pressing ethical issues that had not been considered during the design phase but came up soon after the product had been launched, as, e.g., in the case of the Google Glass, the production of which was ceased due to privacy concerns (Kudina & Verbeek, 2019). Additionally, even the successful commercialisation of a technological product comes with huge costs and can take up to a decade (Pervaiz Ahmed & Shepherd, 2010). Thus, the development of technological products and services requires sequential investment decisions (Dissel et al., 2009).

A traditional method to evaluate decisions in economics is the cost-benefit analysis (Drèze & Stern, 1987), where benefits and costs are weighed in order to identify the best option, or in the present context, the best decision regarding the design of and investment in an IT product. However, prevailing methods for technology valuation borrowed from finance fall short in accounting for the uncertainty of early-stage technologies (Dissel et al., 2009). Dissel et al. (2009) argue that it is essential that potential "threats and opportunities arising from future events" (p. 46) are recognized to "improve the design of the technology development project" and "support the business case for technology investment decisions" (p. 47).

Traditional IT innovation approaches with a focus on linking strategy and operations with technological capability result in value propositions that emphasize technological function instead of actual values for various stakeholders. In contrast, a critical evaluation of a technological product's impact before product development increases the product's chances of success on the market and with it the organisation's economic success. When such an evaluation takes place in the design phase, anticipated value effects can inspire product design adaptations and inform decisions on its investment. More importantly, an evaluation should not only focus on preventing value harms such as those that have been observed by Gimpel and Schmied (2019), but also create beneficence (Jobin et al., 2019) through a design that fosters positive value potentials. According to Venkatesh et al. (2012), vendors should consider consumers' utilitarian, hedonic or other important values to maximise profits. Roger's (2003) diffusion model also emphasizes that a product needs to be compatible with the values, past experiences, and needs of an individual in order to be accepted. A value-based analysis of the underlying technology can support traditional IT innovation strategies by providing additional information on the potential impact of a technological product.

2.5.4. Traditional and Value-Based IT Innovation Strategies

When investment decisions are based on a set of relevant values, different criteria might inform the decision-making process. When individuals are asked to decide whether they would invest in a technological product or service for which several potential value harms and value benefits have been identified, they could base this decision on a ranking of values, prioritizing some values over others. However, I could not identify any study that investigates which dynamics are at play when individuals make a value-based investment decision or which strategies could accompany a value-based decision-making process. And still, the literature on how to deal with design decisions based on a set of values that are potentially in conflict (de Graaf, 2021; Meijer & De Jong, 2020; van de Poel, 2015) provides examples for strategies that could also be relevant for value-based investment decisions.

For example, Hulstijn and Burgemeestre (2015) proposed a value-based argumentation process where stakeholders challenge design choices based on a critical reflection of underlying assumptions until they reach agreement. The concept of *value dams and flows* (Miller et al. 2007) can supposedly result in resolving value tensions among design choices by helping to identify design options that stakeholders reject (value dams), which should be removed, and those that stakeholders find appealing (value flows), which are to be incorporated (Friedman et al., 2017). Van de Poel (2015) proposes a sequential process that involves established concepts such as value dams and flows but also enables rethinking the problem to come up with a new solution. In a different approach, a *best worth method* has been suggested to rank values by weighing each value in one or several dimensions until a final ranking is reached (van de Kaa et al., 2020). Then again, Miller (2021) has argued that a set of relevant negative values might warrant the decision against designing a technology at all rather than weighing harms against benefits. In general, risk-benefit evaluations can differ substantially depending on whether harms are avoided at all costs or accepted when they can be balanced with benefits (Jobin et al., 2019), making such evaluations highly subjective.

Next to value prioritization methods, studies have looked into how individuals deal with situations where important values are in conflict. For example, de Graaf (2021) tested six coping strategies that had previously been proposed in the literature in a recent empirical study on value conflicts in academic teaching. The strategies included shifting responsibility to other entities (*firewalls*), not recognizing some values as important (*bias*), basing decisions on previous experiences in similar cases (*casuistry*), allowing that important values are overturned by other values over time (*cycling*), combining conflicting values (*hybridization*), and putting more and more emphasis on one particular value (*incrementalism*). De Graaf (2021) reported that quality and efficiency were among the most important conflicting values for teachers and that most teachers dealt with this value conflict by applying the hybridization strategy.

However, these results cannot be generally transferred to different areas of interest: the social context always influences how values are prioritized and systems designed (Hulstijn & Burgemeestre, 2015). In the corporate culture, embedded values such as profit, safety, or quality might have an impact on value prioritization (Hulstijn & Burgemeestre, 2015). Thus, it is not clear how individuals come to value-based IT investment decisions in different contexts when they are not required to follow specific instructions or methods that guide their decision-making process. Guided by the main research question (RQ3) “How Does Value-Based Thinking Influence IT Investment Decisions?”, I aim to explore how ethical perspectives can support a critical value-based evaluation of a technology’s design and whether identified value harms and benefits influence IT investment decisions.

From the body of the literature presented above, I derive the following specific research questions regarding the decision-making process that results in an investment decision.

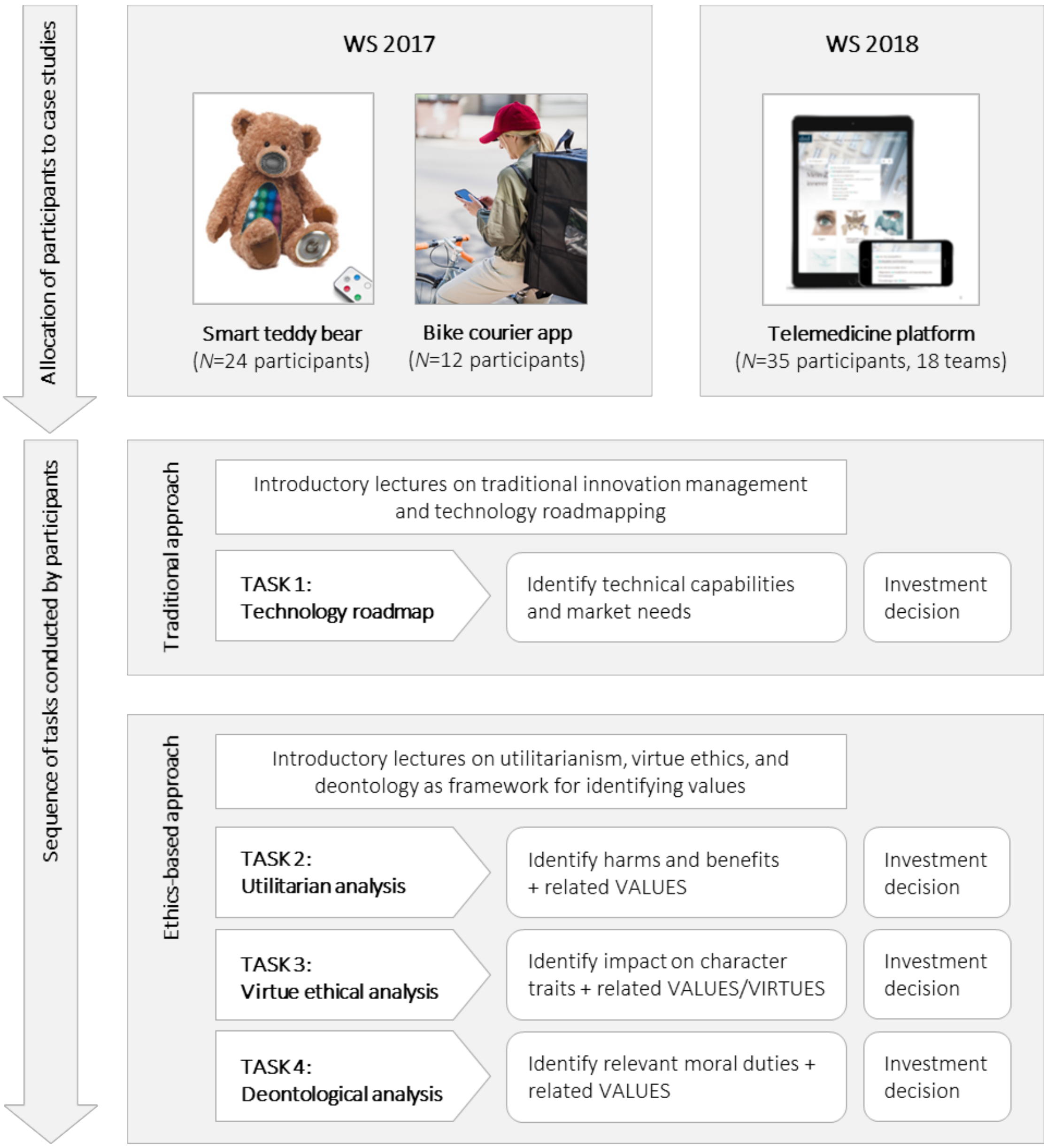
- **Research question 3.1:** Do ethical perspectives change investment decisions for a product/service that was initially described in a traditional technology roadmap?
- **Research question 3.2:** If yes, how do individuals decide? Do they base their decision on weighing positive and negative value effects or do they give priority to either value benefits, value harms, or individual values?
- **Research question 3.3:** Which patterns can be observed in investment decision-making? Are there common pattern across ethical theories or do the ethical perspectives of utilitarianism, deontology and virtue ethics exhibit specific effects on how individuals come to their decisions?
- **Research question 3.4:** Finally, how do value-based improvements of an IT product/service affect initial decisions made against investing?

To answer these questions, I will look into patterns of individuals' decisions pro investment and against investment and analyse how they explain and justify their decisions. I will take the specific ethical perspectives into account but also consider whether the number of identified positive and negative value effects influences the motivation to invest.

3 Method

Over two years, my PhD supervisor Sarah Spiekermann-Hoff and I collected data to answer the research questions specified above (see Section 1.2 and Figure 1 for an overview). Figure 9 shows the procedure of our empirical study that I describe in full details in the following sections, including task instructions (3.1), sample (3.2), investigated technologies (3.3), data analysis (3.4 and 3.6) and dependent variables (3.5).

Figure 9. Procedure showing participants, case studies, preparation, and tasks



3.1 Procedure and Instructions

In the winter semester 2017, 36 students enrolled in the Information Systems master programme at the Vienna University of Economics and Business engaged in two IT innovation tasks: technology roadmapping and an ethics-based technology design approach with a focus on values. They were split into two groups and worked on either a smart teddy bear or a bike courier app. We repeated the study one year later with 35 students working on yet another information system: a telemedicine platform. In the following, I show the detailed instructions that the participants followed in the study (3.1.1) and describe how the participants noted down their ideas (3.1.2). To answer RQ3.4 on whether value-based improvements influence investment decisions, we conducted an additional mini-study in the summer semester 2021, which I describe in Section 3.1.3.

3.1.1. Preparation and Task Instructions

In both semesters, students first received roughly six hours of introductory lectures on innovation management and technology roadmapping. They were then asked to develop a technology roadmap for the respective IT product by reflecting on technological developments and market competition and identifying important product characteristics and related technological features (see Appendix B and Appendix C for details).

After completing this first innovation task, the same students again received six-hour introduction to the three ethical theories of utilitarianism, virtue ethics, and deontology. Based on Spiekermann (2016), they heard about the core ethical reasoning of these theories and their most prominent proponents. When introducing utilitarianism, different forms of general, act- and rule-based utilitarianism were discussed (Frankena, 1973), as well as the criticisms utilitarianism has faced in the philosophical literature (Frankena, 1973; MacIntyre, 2007; Nagel, 1989). Drawing on role models in the literature and in film, students learned that the concept of virtue is grounded in the wider notion of the Aristotelian golden mean and the concepts of *arete* and *phronesis* (Aristotle, 2004). Regarding Kant's deontology and categorical imperative (Kant, 1785/2011), great emphasis was put on explaining the concept of personal maxims, along with de La Rochefoucauld's taxonomy of duty (1664/2005). Emphasis was also put on not confusing personal maxims with contempary value norms or ideologies, as criticized by Hannah Arendt (1965/2006), e.g., to abstain from thinking what CEOs would want. The participants then learned how the three theories can be used as a framework for eliciting values (Spiekermann, 2016). In this ethics-based innovation task, the participants reconsidered the technological product or service for which they had developed a roadmap and conducted three ethical analyses. First, they noted down 1) potential benefits and harms that arise for stakeholders (utilitarianism), 2) impacted stakeholder virtues (or vices; virtue ethics), and finally, 3) personal maxims that could be undermined or should be fostered by the innovation (deontology), see Table 2 for an overview and Appendix B and Appendix C for details.

When labelling their ideas for potential benefits, harms, virtues and maxims in the ethical analyses, the participants were asked to reflect on the underlying value that best represented their critical moral thinking and note it down for each of their ideas. They also derived product characteristics to address how the respective value can be considered in the technology's design: In each ethical analysis, they were asked to suggest changes to the product design that they had come up with in the technology roadmap to either prevent the identified potential value harm or foster the positive value. Additionally, after the roadmapping task and in each subsequent ethical analysis, the participants were asked whether they would recommend to invest in the product. As explained in detail below (Section 3.4 "Data Coding and Content Analysis"), we qualitatively analysed the ideas noted down by the participants before conducting quantitative analyses. Table 2 shows a summary of the instructions for each task and the resulting data structure.

The participants employed the perspectives of utilitarianism, virtue ethics and deontology in three subsequent analyses. Together with my supervisor, we chose this order based on results of two small pilot studies that I shall not present in more detail here. These studies show that utilitarianism triggers the highest number of ideas, offering a good starting point, while deontology provides the most critical perspective, qualifying best as the ethical analysis last in order. When applied jointly in a practical setting, the deontological perspective can validate values and virtues previously identified by, e.g., the utilitarian perspective, to emphasize those that deserve the greatest attention in the design process through triangulation (Mingers, 2001), instead of overemphasizing central or mainstream value themes.

Wherever I present the "corrected" number of ideas (e.g., the number of value ideas that the participants came up with in the roadmapping task compared to the ethics-based task) in the results further below, I have controlled for a potential influence of the order of innovation tasks and ethical analyses. I excluded ideas that a participant repeated in a later analysis for value fluency, flexibility, and originality as well as for the fluency of product ideas, the number of acknowledged stakeholders and adverse effects.

Table 2. Instructions and resulting data structure for the technology roadmap and ethics-based approach

	Instructions	Resulting data structure
Technology roadmap	List and prioritize the core characteristics that the product/service should have over time and put them into a technology roadmap that spans the next 5 years. Given the product/service characteristics, what technical capabilities detail these? Align the technical capabilities needed with the characteristics in the roadmap. Think about potential competitors of the product/service. Does the competitive analysis add any technical capabilities to your roadmap? What option do you consider best: digitalization of all product/service characteristics, of parts of them, or no digitalisation at all?	• Product characteristics [o] • Related values/virtues [q] • Affected stakeholders [q] • Investment decision [o]
Ethics-based approach	Utilitarianism Identify benefits and harms associated with the widespread use of the product/service [plus affected direct or indirect stakeholders]. For all benefits and harms identify the value(s) they are related to. Note down: Which product characteristic(s) could foster/protect these values? Based on a utilitarian weighing of benefits/harms and related value, would you invest in the technology?	• Benefits and harms [o] • Related values/virtues [o/q] • Related product characteristics [o] • Affected stakeholders [q] • Investment decision [o]
	Virtue ethics Identify implications of the product/service for the character and/or personality of direct and indirect stakeholders. Identify the virtue(s) or vice(s) that could result from the widespread use of the technology. Note down: Which product characteristic(s) could foster/protect these virtues? Would you invest in the technology?	• Character implications [o] • Related values/virtues [o/q] • Related product characteristics [o] • Affected stakeholders [q] • Investment decision [o]
	Deontology Identify personal maxims that you would want to be recognized as universal laws and that you see fostered or harmed by the widespread use of the product/service. Identify the value(s) your maxims are related to. Note down: Which product characteristic(s) could foster/protect these values? Would you invest in the technology?	• Personal maxims [o] • Related values/virtues [o/q] • Related product characteristics [o] • Affected stakeholders [q] • Investment decision [o]

Note. In the last column, [o] indicates data originally provided by the participant and [q] indicates that the data was qualitatively analysed and potentially added or transformed, e.g., when we adapted the original label of the participants or extracted the stakeholders that the participants mentioned.

I also want to note that when I hereafter mention “utilitarianism,” “virtue ethics,” or “deontology” in the presentation and discussion of findings, what I refer to in brief is the utilitarian, virtue ethics, and deontological analysis conducted by the participants in the empirical study as described in Table 2.

In order to compare the patterns of results across the two semesters and the investigated technologies, we kept the study designs as similar as is possible in a non-laboratory context. Still, we changed some aspects of the study design in the second study iteration in the winter semester 2018, when the participants worked on the telemedicine platform. First, the participants were required to explicitly list potentially affected direct and indirect stakeholders *prior to* the technology roadmapping task and to associate relevant stakeholders with each of their ideas in the ethics-based task. In contrast, in the first study iteration, the participants were required to list stakeholders only *after* the roadmapping task. Second, in the first study iteration, the instructions for the ethical analysis asked the participants to both identify value effects (e.g., harms and benefits for utilitarianism) *and* come up with product improvements based on the identified effects. This made it difficult to understand what influenced the participants’ investment decision, which they provided at the end of each ethical analysis. Did the participants base their investment decision on the value-based issues and potentials they had identified in the ethical analysis or did they (also) consider the product improvements that they had suggested? To avoid these confusions, we decided to split up the identification of value-based effects and ideas for product improvement in the second study iteration (as further described in Section 3.5.4 “Investment Decisions”). Third, I created an online interface to capture participants’ ideas in the second study iteration, which I describe in detail in the following section.

3.1.2. Capturing Participants’ Ideas

The participants entered their ideas for the respective IT product into a template that had been prepared for the technology roadmap as well as for the ethical analyses. In the first study iteration in 2017, this was a text file that included the instructions in text form as well as tables that the participants should use to enter 1) ideas for product characteristics in the technology roadmapping task and 2) ideas on potential benefits, harms, virtues and maxims in the ethical analyses (see Appendix B “Instructions (First Study Iteration)” for the instructions we used). In the second study iteration in 2018, I created an online interface that supported participants in the value elicitation process and provided a standardized means for entering ideas.

As shown in Appendix C "Instructions (Second Study Iteration)", this online interface walked participants through each step of the ethical value elicitation process by showing instructions for the respective analysis on the screen and providing fields where participants could enter their ideas. In the first phase of each ethical analysis, the participants were asked to identify how the initial product proposal (captured by the technology roadmap) was likely to affect stakeholders by considering (1) harms and benefits in the utilitarian analysis, (2) affected characteristics of the stakeholders' respective behaviours and characters in the virtue-ethical analysis and (3) effects that were in line with or opposed to the personal maxims they identified as important in the deontological analysis. The interface allowed participants to enter as many ideas as they wanted in the following structure: description (of effect)—harmful/beneficial—stakeholder(s) affected—related value/virtue. In the second phase, the positive and negative value effects that the participants had identified in the respective ethical analysis were shown to the participants one by one and they were asked to provide ideas for product improvements to 1) further increase positive value effects and to 2) prevent negative value effects. With each idea that was completed, a new field appeared that allowed participants to enter further product improvements. The online interface provided the possibility to fill in as many as 10 product improvements for each of the identified value effects, but the participants came up with a maximum of four improvements for one value effect.

3.1.3. Follow-up Study

Once all three research questions had been answered based on the empirical data resulting from the two innovation tasks just described, we conducted an additional follow-up study in order to collect supplementary data on investment decisions in the summer semester 2021. For this mini-study, we again presented the bike courier app to 31 new students (22.6% female). All participants came up with a technology roadmap for the fictitious bike courier app and were then asked to conduct an ethical analysis of the product from one ethical perspective, resulting in three groups: utilitarianism (n = 11), virtue ethics (n = 12), and deontology (n = 8). Prior to and after the ethical analysis, they were asked whether they would invest in the product. This additional data was collected to provide an indicator for whether any effects discovered in the analyses of the two study iterations before could be ascribed to order effects resulting from the participants conducting all three ethical analyses subsequently.

3.2 Sample

The participants were students at the Vienna University of Economics and Business enrolled in an Information Systems master programme. The requirements for enrolment in this programme are 700 full hours (28 ECTS) of computer science training and at least 1,500 hours (60 ECTS) of business management and/or economics training. Thus, the participants had a solid technological and economic background for an IT innovation management task. Also, 74% of master students registered at public universities in Austria are known to work at least 20 hours in addition to their studies (Unger et al. 2020), so they have substantial professional experience. Only those participants who completed all analyses of the respective IT product were included.

All samples showed a rather balanced distribution of gender and a diverse national background. In the winter semester 2017, there were seven Austrians (19.4%) plus participants from 20 other nationalities (including Albanian, Bosnian-Herzegovinian, Bulgarian, Croatian, Danish, Dutch, German, Greek, Hungarian, Indian, Latvian, Macedonian, Palestinian, Serbian, Slovakian, Thai, Turkish, USA, and Russian). The 36 participants were split into two groups. They worked individually on the fictitious product scenario of a smart teddy bear as a toy for children ($N = 24$, age: $M = 24.4$, $SD = 3.0$; 54.2% female; 16 different nationalities) or on a bike courier app for food delivery to households ($N = 12$, $M = 23.0$, $SD = 1.5$; 50% female; 9 different nationalities).

In the winter semester 2018, 13 participants were female (38.2%) and 21 participants were male (61.8%; 1 missing value). On average, they were 25 years old ($M = 24.6$, $SD = 2.6$). Around half of the participants were Austrian (53.6%), the rest held 13 different nationalities (Albanian, Finnish, French, German, Indonesian, Korean, Dutch, Peruvian, Romanian, Russian, Serbian, Slovakian, and Swiss; 3 missing values).

3.3 Case Studies and Investigated Technologies

My supervisor and I chose three different IT products to find out how the different approaches (technology roadmap and the three ethical analyses) would play out in different technology settings. We wanted to test whether products and services that differ in their form factor and use contexts, as well as the ethical issues and implications they bring along, would lead to a different consideration of values.

To explore yet another technology, we repeated the procedure one year later with a few adaptations. Most importantly, we chose a real-world case of a telemedicine platform that a start-up planned to build and presented as a case to our students. To encourage an exchange of ideas among the students, we asked them to form teams of two for working on the telemedicine platform, resulting in 18 teams, with one student working on her own. In the following, I provide descriptions of the technological products and services that the participants analysed: a bike courier app (3.3.1), a smart teddy bear (3.3.2), and a telemedicine platform (3.3.3). Table 3 summarizes important characteristics of the three technology cases.

Table 3. Overview of investigated technologies

	Bike courier app	Smart teddy bear	Telemedicine platform
Type	B-2-C plus internal management	B-2-C	B-2-C
Business case	Fictitious case	Fictitious case	Real-world case
Presentation	Information provided in text document	Information provided in text document	Information presented by the CEO
Number of participants	*N* = 12 (Group A)	*N* = 24 (Group B)	*N* = 18 teams (25 individuals)
Examples for associated values	Efficiency, productivity, comfort	Fun, joy, privacy, security	Health, equality, efficiency, transparency

In the winter semester 2017, students were split up into two groups that should have had an equal number of participants assigned to either the smart teddy bear or the bike courier app. Unfortunately, a few students switched groups without informing us. Also, we had to exclude students who did not submit complete tasks, which together resulted in imbalanced subsamples.

3.3.1. Bike Courier App

In group A, 12 students worked on the design of a bike courier app, a smartphone application that organizes the tasks, contracts, and payments of couriers who deliver food from restaurants to private consumers by bike. The case of the bike courier app was based on *Foodora*[4], the market-leading company offering such a bike courier service in Vienna at the time. The participants were given the following case description.

[4] https://www.foodora.com/

> The management of fleets (i.e., taxi drivers, lorry drivers, biking couriers) has increasingly been digitalized. Also, scheduling systems or shift-management systems have evolved. The promise for corporations using such digital planning- and resource management software solutions is one of greater efficiency and productivity.
>
> Imagine that the company Foodora is about to offer its first bike-courier service in Vienna and—together with an IT service provider called 'ITforYou'—the company needs to develop a new job assignment courier app to manage bike couriers. The target segment is made up of all people living in Vienna from the 1st to the 23rd district.
>
> Put yourself in the position of the new product manager at Foodora for this new job assignment courier app. You have just joined the company and your role is to oversee the development of the new app. You would want to stay working for Foodora for the next 5-10 years at least. So, your task is to make the food delivery market work for Foodora!

The bike courier app was chosen as a technology case because it represented a new digital service that has been taken up quickly and with great enthusiasm by costumers and cooperating restaurants. A bike courier app supports B-2-C services (customers can order food and receive information on the delivery status when using the app) but can also be used by the companies to manage transactions (e.g., monitor food deliveries or payroll) and employees (e.g., through digital contracts). Thus, it combines traditional economic values such as efficiency with individual values such as comfort. What is more, the delivery on bike implies an appreciation of the natural environment, while at the same time posing challenges for the bikers' safety.

Since 2017, the case of Foodora has become even more ethically relevant as the company has been in the news because of its tough policies and low hourly wages for bikers (Chau, 2018). In cases such as Foodora, the digital platform is the means which allows the company to exceed control and limits the autonomy of the bikers (Ivanova, Bronowicka, Kocher, & Degner, 2018) because contracts and shifts are managed by the digital platform, e.g., through automated job assignments. This shows that the impact of a technology on affected stakeholders has high moral relevance, especially in a context with unequal power relationships. Recent research has shown that Foodora was predominantly associated with negative work-related discussions (Geissinger, Laurell, Öberg, Sandström, & Suseno, 2022). Thus, the technology has a severe negative impact on the employed bike couriers, for whom the application represents a necessary tool for occupational purposes. At the same time, the case emphasizes the need to come up with a better design of the digital platform to organize the bike couriers' job assignments for services such as Foodora, Uber Eats, Mjam, etc.

3.3.2. Smart Teddy Bear

In group B, 24 students analysed a fictitious smart teddy bear, which targeted two- to nine-year-old children. The case of the smart teddy bear was based on *Fisher-Price*[5], a well-known company producing toys of various kinds, including educational toys that respond to the child's touch with songs and phrases, among other "smart" functionalities. The participants were given the following case description.

> Toys for kids are increasingly digitized (i.e., teddy bears, barbies, lego bricks). The promise for toy manufacturers offering digital toys is to create unique competitive selling propositions.
>
> Imagine the company Fisher-Price (which belongs to Mattel) considers expanding its business in the digital toys market. It launches a teddy bear that can talk to and interact with kids. The target segment would be kids between 2 and 9 years of age.
>
> Put yourself in the position of the new product manager at Fisher Price for this new toy. You have just joined the company and your role is to oversee the development of the new teddy. You would want to stay working for Fisher Price for the next 5-10 years at least. So your task is to make this market work for Fisher-Price!

This technology case was chosen because a smart toy represents a very personal recreational consumer product specifically designed for children and families in their homes, and thus poses a highly morally sensitive context for the design of an IT product. On the one hand, a smart toy can bring joy and fun and offer new ways of learning and exploration to the child. On the other hand, the technical equipment of smart toys including microphones and cameras raise ethical concerns.

At the time of data collection, digital toys had been in the news because of incidents with moral import. For example, Hello Barbie, a doll by toy producer Mattel that records and processes the child's voice to interact with it and answer via a microphone, had been criticized because of security and privacy issues (Komando, 2015). More recent research shows that privacy, security and ownership are typical examples of the ethical issues smart toys are confronted

[5] https://shop.mattel.com/pages/fisher-price

with, especially those that are connected to computing services in a cloud (Chang, Li, & Ramachandran, 2019). While some regulatory frameworks provide restrictions for smart toys, current toys still lack adequate privacy and security measures, making them vulnerable to attackers (Shasha, Mahmoud, Mannan, & Youssef, 2019).

3.3.3. Telemedicine Platform

In the winter semester 2018, 35 students analysed a telemedicine system that the CEO of a start-up company based in Vienna presented to them. The participants also had access to an early version of the envisioned platform. The telemedicine system under investigation operates by connecting patients to a general practitioner, who makes an online diagnosis and refers patients to specialized doctors highly recommended by their peers. The platform should enable any patient to find the best suitable doctor for his or her medical problem, regardless of the patient's social network. In the following, I summarize important points from the CEO's presentation of the envisioned platform.

> Many individuals refer to search engines when looking for explanations for symptoms or treatments. While there are also medical platforms that collect information on available medical experts, the transparency and quality of the underlying recommendation and rating systems have been criticized. For example, various newspapers reported the case of a webpage that presented ratings of physicians, but allowed physicians to delete ratings if they paid for it. The CEO concluded that health is "too important, to leave it to the free forces of social networks or intransparent selection mechanisms".
>
> The envisioned digital platform enables video chats with general physicians for a medical evaluation. More importantly, it offers a search engine for finding the best medical experts (also for specific diseases) based on the recommendations of other medical experts. A *competence index* visualises the physician's expertise, geographical distance and number of recommendations in a way that is transparent for the user. Physicians cannot manipulate their ranking through subscriptions, guaranteeing a high quality and independence of the recommendations. Patients can schedule appointments and contact the physician through the platform.

While the apparent envisioned beneficial effects of this IT product are related to values such as health, equality, and efficiency, the underlying recommendation system and the telecommunication system also raise ethical issues, especially as they are used in a medical context. For example, there is the difficulty to validate the justification for a recommendation among doctors, who might know each other and try to support each other. Also, the lack of physical interaction could impair the doctor's decision-making and diagnosis skills. What is more, the medical context is especially sensitive when it comes to potential privacy and security breaches. Thus, this technology case offered the opportunity to come up with design ideas that would preserve the morally desirable features of the digital service while at the same time protect against potential harms.

3.4 Data Coding and Content Analysis

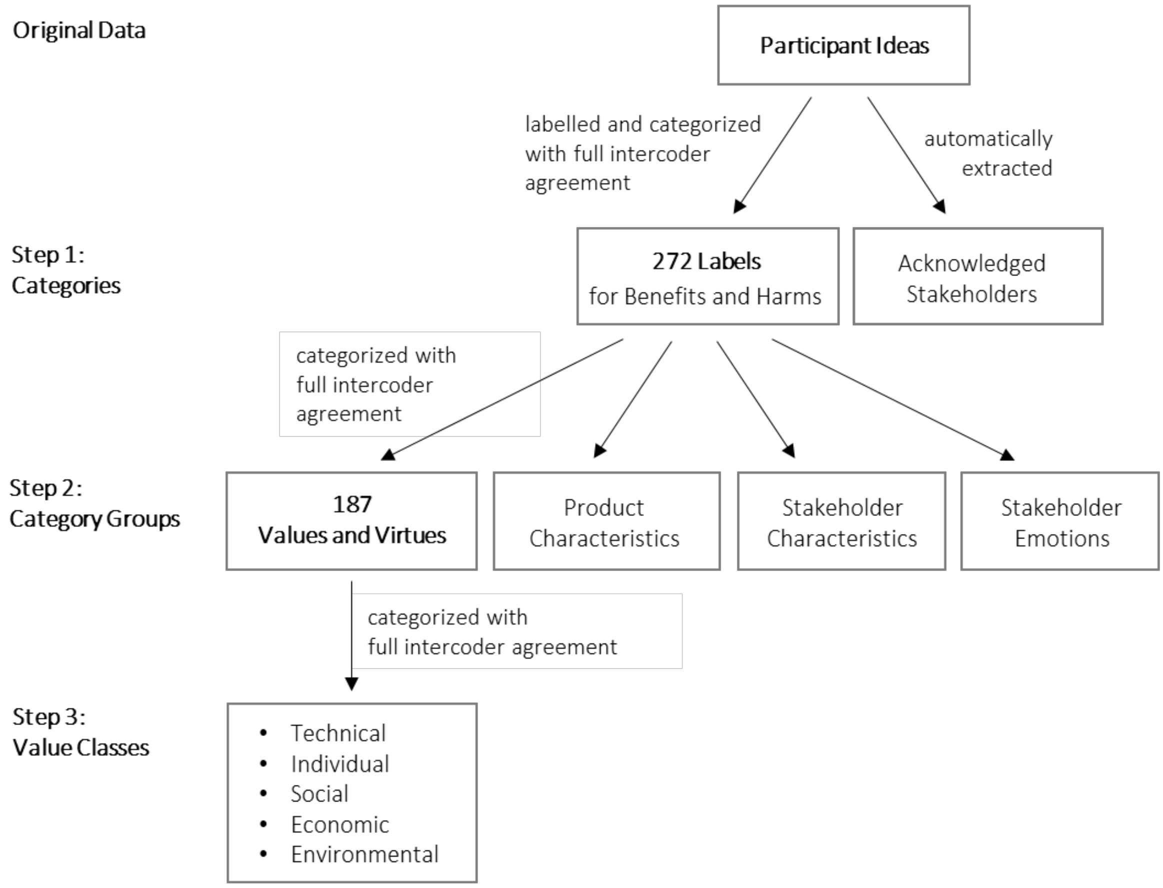
Innovative thinking is a highly creative exercise (Amabile, 1997). To capture the meaning of the 2,119 ideas collected from the participants for the (re-)design of the respective IT product, I qualitatively analysed the data together with my supervisor and three supporting student coders in a highly elaborate process with several steps, which I describe in detail below. Figure 10 presents a schematic overview of this process and of the higher-level category groups and value classes that were assigned to the original participant ideas.

In the next sections, I describe how I assessed intercoder agreement (Section 3.4.1) when developing a category system that represented the participants' ideas (Section 3.4.2). The category system distinguished between values, virtues, and other categories, as described in Section 3.4.3. I also categorized ideas related to values on a more abstract level in terms of value classes (Section 3.4.4). When I refer to participants' "ideas" in the following, I denote what the participants wrote down in the respective tasks, e.g., a list of harms and benefits and related values in the utilitarian analysis. "Value ideas", then, are only those ideas of the participants that were classified as actually relating to values or virtues (instead of merely describing, e.g., product characteristics, see Section 3.4.3). Finally, "values", when used in relation to the participants' ideas, refer to the values and virtues that "value ideas" related to (e.g., privacy). As the participants noted down different ideas relating to the same value or virtue, the number of value ideas exceeds the number of values.

3.4.1. Assessment of Intercoder Agreement

In the development phase of the category system, I checked whether intercoder agreement reached common thresholds for reliable coding. Intercoder agreement is an important quality criterion for the subsequent analysis and interpretation of the resulting categories and their frequencies and can be evaluated in various ways.

Figure 10. Overview of the coding process including developed category groups and value classes



Simple indicators for intercoder agreement are percent agreement, which represents the percentage of units that two coders agreed upon in their coding decisions, or the Holsti index, which takes into account two coders choosing different text segments as relevant coding units (Lombard, Snyder-Duch, & Bracken, 2002). However, these simple indicators are considered too liberal as they do not account for agreement by chance (Krippendorff, Mathet, Bouvry, & Widlöcher, 2016; Lombard et al., 2002). The ATLAS.ti software allows computing Krippendorff's alpha and Krippendorff's cu alpha. These indices were designed for analysing relevant text segments that are not previously defined but have to be decided upon by the coder/s (Friese, 2018). Still, the software does not acknowledge the case of the current study, where almost all relevant text segments considered for the assignment of categories are *unique*, i.e., hardly any text segments were assigned to more than one category. Thus, the use of the index provided by the software would be misleading.

Therefore, I decided to use Cohen's kappa (κ; Cohen, 1960), which is a conventional index for coder agreement. κ is defined as $\kappa = (f_o - f_c) / (N - f_c)$, where f_o is the proportion of units in which the judges agreed, f_c is the proportion of units for which agreement is expected by chance, and

N is the total number of units assessed by each judge (Cohen, 1960). I computed Cohen's kappa manually and evaluated it according to the thresholds of Landis and Koch (1977), who consider the strength of agreement *moderate* for a kappa statistic of 0.41–0.60, *substantial* if it lies between 0.61–0.80, and *almost perfect* if it ranges between 0.81–1.00.

According to Lombard et al. (2002), disagreements between coders can be resolved by either "randomly selecting the decisions of the different coders, using a 'majority' decision rule (when there is an odd number of coders), having the researcher or other expert serve as tie-breaker, or by discussing and resolving the disagreements" (p. 601). As I considered reliable data highly important for further analyses, I resolved all cases of disagreements in discussions with the respective coders until full agreement was reached. This often resulted in an iterative process where I adapted the category definition that was used for categorizing a participant's idea whenever the definition seemed incomplete, too precise, or too liberal.

3.4.2. Category System Based on Labels for Participants' Ideas

In the first study iteration, we had expected the participants to follow the structure that was provided in the respective text documents, which contained instructions and tables for filling in their ideas. However, several participants did not make use of the tables and created their own formatting, e.g., using lists. This resulted in differently structured ideas which were difficult to analyse and compare. One difficulty was the differing level of detail of the descriptions of the envisioned product impact (e.g., an undermined personal maxim). While some participants gave very elaborate answers, others provided only very generic descriptions of their ideas. The related values that participants had noted down with each of their ideas in the ethical analyses were even more problematic. Participants often attached several different related values to one idea or linked a generic value to a very specific value description. To ensure comparability, I decided to go through the collected ideas and develop a category system for assigning common labels (categories) to participants' idea descriptions.

With an undergraduate student (M.T.S.) as assisting coder, I first deductively developed a category system by conducting a qualitative content analysis (Mayring, 2014) of the entire set of ideas resulting from the participants' technology roadmap and ethical analyses of the bike courier app and the smart teddy bear. This category system represented the original ideas through common labels whereby the direction of effect could be either positive, negative or neutral. For example, if the smart teddy bear inadvertently passed on data, it would be coded as a "negative" effect relating to "privacy". I improved the category system iteratively by discussing disagreements and difficulties with the assisting coder M.T.S. and my supervisor, respectively. Once the category system adequately represented the qualitative data from the analyses, I formulated precise coding rules and category definitions.

Next, I recruited two undergraduate research assistants A.Z. and P.S. to code the data resulting from the bike courier app and the teddy bear independently from each other using the developed codebook (see Appendix D “Category System” for the final categories). The coders were introduced to the underlying ethical theories of the value-based system design approach and were instructed on how to apply the category system over the course of several training sessions in June 2018 (15 hours). For this training phase, the two coders first conducted the same exercises as the participants to gain a better understanding for the task. Under my supervision, they practiced coding with data that had been excluded from the final data analysis (e.g., incomplete submissions). Once they were familiar with the tasks and the background, the two coders applied the category system independently from each other to a first sample of data (six cases for the smart teddy bear and the bike courier app each) and were then provided with the whole dataset. Coding was conducted with the ATLAS.ti software, which enables computing category frequencies and thereby also provides a quantitative understanding of the underlying data. After the first round of coding, intercoder agreement was assessed and the codebook and coding rules were further refined. Intercoder agreement showed *good* agreement for the first sample of the dataset ($\kappa = 0.74$ for the smart teddy bear and $\kappa = 0.78$ for the bike courier app) and *substantial* agreement for the final coding of the complete dataset resulting from the smart teddy bear ($\kappa = .69$) and the bike courier app ($\kappa = .65$). We resolved all cases of disagreement through discussions with the two coders, which resulted in a further refined category system.

Then, my supervisor and I applied the category system to the participants’ ideas for the telemedicine system with an initial agreement of 81.8%. Again, the category system was iteratively refined through discussions until we reached full intercoder agreement, resulting in 272 categories with different directions of effect (harmful, beneficial, neutral; e.g., “Privacy [harmed]” and “Privacy [fostered]”) shown in Appendix D “Category System”. When categories are considered without the direction of effect (e.g., “Privacy”), the category system contains 185 categories.

3.4.3. Values, Virtues and Other Category Groups

In a second qualitative analysis, my PhD supervisor and I grouped all 185 categories on a higher level of abstraction, filtering 114 values and virtues from three other category groups that we identified in the data, i.e., *product characteristics* (e.g., reward system, health monitoring, or entertainment programme), a stakeholder's *personal characteristics/abilities* (e.g., increased curiosity, humour, or social skills) and *emotions* (e.g., feeling rejected or joy). We derived these three category groups from the qualitative data and assigned each category exclusively to one category group. Table 4 shows the coding instructions we established and examples for each category group. We refined the definition of the category groups until we reached full agreement on the categorization of all categories. The number of categories in each category group and the related share of ideas are also provided in Table 4.

The biggest group was made up of *product characteristics* (representing 18.7% of all original ideas), which described the IT product or specific features of it and did not qualify as *values*. We classified categories as *values* if they represented a good that is valuable in itself (i.e., an intrinsic value such as freedom or health) or a means to such a higher value (i.e., an instrumental value such as accuracy or transparency). Also, we classified categories as *virtues* if they described how the respective IT product influenced long-term morally good character traits or dispositions in affected stakeholders that are socially desirable and appreciated (e.g., considerateness or kindness). We understand virtues as *values inherent in the good character and conduct of a person*, and thus include them when we henceforth refer to "values" or "value ideas".

In several cases, the participants probably had a virtue in mind, but described a stakeholder's *personal characteristic or ability* that we struggled to categorize as good or socially desirable. For example, curiosity could be a good long-term character trait if it motivates people to engage in new activities and learning. At the same time, it could also cause a person to transgress boundaries only to get hold of certain information. Thus, we did not categorize it as a virtue. Similarly, the participants thought of certain beneficial as well as negative effects for different stakeholders that we did not classify as values because they described an emotional state or experience. For example, while we considered joy as something desirable and good, participants used it to describe situations where stakeholders "felt joy", e.g., when watching a child happily playing with the smart teddy bear. Thus, we created another category group for stakeholder *emotions*.

Table 4. Coding instructions for category groups assigned to the 2,119 original ideas

Category group	Share of ideas	Coding instruction	Examples
25 intrinsic values	26.8% of ideas	This category encompasses positive and negative intrinsic values that are either supported or harmed. Intrinsic values are good and valuable in themselves (not for something else). When there is no answer to the question "What is [*the value*] good for?" the value is an intrinsic value.	Freedom, Health, Safety
42 instrumental values	30.0% of ideas	This category encompasses positive and negative instrumental values that are either supported or harmed. Instrumental values cannot be seen as ends in themselves, they describe extrinsic values that are a means to achieve a higher intrinsic value. The question "What is [*the value*] good for?" helps to decide whether the value is really instrumental (extrinsic) or an end in itself (intrinsic).	Accuracy, Transparency, Convenience
47 virtues	16.7% of ideas	This category encompasses virtues and vices that are either supported or harmed. Virtues describe values that lie in the human conduct and are considered expressions of moral excellence or long-term morally good character traits that are socially desirable and appreciated. Vices describe the opposite.	Considerateness (virtue), Kindness/Friendliness (virtue), Jealousy (vice)
13 personal characteristics and abilities	4.8% of ideas	This category encompasses characteristics and abilities of a person that are either supported or harmed. While they can describe character traits and skills that are socially desirable, they do not indicate moral excellence and thus do not qualify as virtues.	Curiosity, Social skills, Spontaneity
13 emotions	3.1% of ideas	This category encompasses the positive or negative experiences of sentient beings that are accompanied by a specific, more or less consciously perceived bodily state.	Affection, Feeling joy, Feeling rejected
45 product characteristics	18.7% of ideas	Product characteristics describe the product/service and its specific (technical) features, capabilities or processes.	Scheduling function, Notifications, Search engine for information

Note. For each category group, the number of categories that fall within this group are indicated. For example, there are 42 instrumental values, including, e.g., ease of use. The percentage shows the share of original ideas that are represented in each category group, not the share of categories.

3.4.4. Value Classes

Kheirandish et al. (2020) argue that a value framework needs a basic structure that underlies the concept of values and categories for value groups. To qualitatively distinguish between different classes of values, I used the value classification by Winkler and Spiekermann (2019), which is based on dimensions of sustainability. These dimensions span social, technical, individual, economic, and environmental sustainability as well as combinations of these (social and individual sustainability, social and technical sustainability, or even all five dimensions). My supervisor and I independently assigned each value or virtue to a value class that supports one of the five sustainability dimensions as well as the overlapping area between these dimensions (e.g., social and technical values). Throughout the coding process, we followed the coding instructions that we had established for each value class. See Table 5 for the description of value classes that we used.

Table 5. Coding instructions for value classes

Value class	Coding instruction	Examples
Technical values	Technical values describe positive and negative values that are carried by a technology but bring value to humans.	Ease of use, IT security, Reliability & robustness
Economic values	Economic values describe positive and negative values that are important from the perspective of economic agents (e.g., companies or customers).	Competitive power, Monetary benefits, Innovation
Individual values	Individual values describe positive and negative values that are important for individuals. Individuals bear these values, as the underlying behaviours and character traits are bound to them.	Comfort, Laziness (negative), Personal growth
Social values	Social values describe positive and negative values that are important for the interaction and coexistence of people.	Community, Equality, Human contact
Social & individual values	Social and individual values describe positive and negative values that are important for an individual living within a social context.	Commitment, Helping others/Helpfulness, Trust
Social & technical values	Social and technical values describe positive and negative values that combine a technological aspect with social implications.	Accessibility, Machine-human friendship, Trust in technology
Environmental values	Environmental values describe positive and negative values that relate to the natural environment and its resources.	Environmental protection

In the coding process, we used the *overarching values* listed by Winkler and Spiekermann (2019) as an orientation for the values subsumed by each dimension. In some cases, the label we used for a value did not coincide with an overarching value, but with a *specific aspect* that Winkler and Spiekermann associated with an overarching value. For example, the value category "fairness" that emerged in our data was mentioned as a specific aspect of the overarching value "justice" and related to social sustainability in the categorization of Winkler and Spiekermann. We discussed disagreements and iteratively refined the definitions of the value classes until we reached full agreement. Appendix D "Category System" shows the final and complete category system with all categories arranged in the category groups intrinsic values (Table D1), instrumental values (Table D2), virtues (Table D3), personal characteristics and abilities (Table D4), emotions (Table D5) and product characteristics (Table D6). All values and virtues are additionally divided into value classes (e.g., social and individual values).

3.5 Resulting Dependent Variables

3.5.1. Quantitative Value Creativity Variables

While I embrace the view that an assessment of creativity should focus on the creative *product* rather than the *process* or the *person*, the within-subject design that I apply to compare different approaches draws on the evaluation of the creative person in several aspects. I evaluate how a participant's ideas differ in terms of value creativity when using different approaches (e.g., traditional technology roadmapping and value-based technology roadmapping) by assessing the number of value ideas that the participant created and the average number of value dimensions that the participant's value ideas covered. Other approaches propose to assess creativity based on an subjective understanding of creativity (e.g., the *consensual assessment technique;* Amabile, 1982). However, such an approach is extremely time-intensive and only allows the investigation of smaller samples of creative output. Thus, I use a quantitative assessment of the participants' output to assess creativity in terms of the number of (value) ideas.

Following Guilford's conceptualization (1966, 1971), I assess the creativity unleashed by the two innovation planning tasks in terms of value fluency, flexibility and originality. As briefly discussed in the Introduction (Section 1.2.2), I use this account of creativity as it is especially well suited to evaluate creativity with a focus on ideas that relate to values. In the following, I define fluency, flexibility, and originality and show how they served to answer the specific research questions presented in Section 2.5.2 on the comparison of "Traditional versus Value-based Roadmapping".

Fluency is typically measured in quantitative terms as the number of responses to an open-ended question (Batey, 2012). In a classic fluency task, participants are asked to list, for example, consequences of a given event, or the potential applications of common objects (Guilford, 1971). To assess *value fluency* (RQ2.1), I focused on the number of value ideas, i.e., ideas that either directly related to a value (e.g., accuracy, convenience, accessibility, etc.) or implied a value. For example, when a participant mentioned encryption for better security or a "secure system" in the technology roadmap, I categorized this implicit value of security as a value idea. The fact that I controlled for idea overlaps to mitigate order effects (as described above) also warrants that fluency refers only to the number of *new* ideas that each participant came up with in the respective tasks.

To address RQ2.2 on the fluency of product ideas, I counted the product characteristics that participants had enlisted in the technology roadmapping task. In the ethical analyses, participants were asked to note down product characteristics (study iteration 1) and product improvements (study iteration 2) that supported each value or virtue that they had identified from an ethical perspective. These product characteristics/improvements relating to values/virtues are not represented in the 2,119 ideas that were qualitatively analysed. I counted them to compare the resulting number to the number of product characteristics from the technology roadmap. In this process, I controlled for potential overlaps especially within the three ethical analyses by not including any product characteristic that had been mentioned by the same participant in an analysis before. For example, when a participant mentioned "battery durability" in the roadmap and again as a product characteristic/improvement supporting, e.g., "ease of maintainability" in the utilitarian analysis, it was only counted as a product characteristic for the technology roadmap.

RQ2.3 looks at how flexible people are in their creative thinking, which combines a qualitative with a quantitative assessment (Guilford, 1966, 1971). I operationalized *value flexibility* as the number of value classes (i.e., sustainability dimensions) covered by a participant's ideas. The corrected number I present only takes those value ideas in account that do not repeat a value category that the participant had mentioned in an analysis before.

The third aspect, originality, addressed by RQ2.4, constitutes a core characteristic that is widely ascribed to creativity (Batey, 2012) and can be judged quantitatively as a "statistical rarity among more popular solutions" (Thys et al., 2014, p. 367). I assessed *value originality* through the infrequency of a value idea mentioned for one of the three IT products, for which I developed a formula, as briefly described in the following. First, I determined the percentage of participants that mentioned each category i for an IT product, which follows previous operationalisations of *rarity* in terms of "the number of subjects who proposed the same idea" (Dean et al., 2006, p. 658). This represented the preliminary idea uniqueness score IOS_i. I then computed the mean originality score POS for each participant's value ideas, linking the originality of the ideas to the person who generated them. This step diverges from common ways to evaluate generated ideas (Dean et al., 2006), but allows the within-subject comparison of ideas generated in different tasks (i.e., roadmapping, utilitarian analysis, virtue ethics analysis, deontological analysis). Lastly, I defined the mean originality score POS so that a higher score signals higher originality, as has been done before (Dean et al., 2006). These steps are represented by the following formula,

$$POS = 1 - \frac{1}{k}\sum_{i=1}^{k} IOS_i \,,$$

where k is the total number of ideas of the participant. I chose this approach to avoid an overly strict and binary view of originality (i.e., classifying an idea as either original or not), which is common in the evaluation of generated ideas (Dean et al., 2006) but would lead to a right-skewed distribution with most people having very few original ideas. The mean originality score per participant, on the other hand, supports a normal distribution with many people having ideas with a medium originality score and few people having ideas that are highly original or not original at all.

3.5.2. Acknowledged Stakeholders

In order to assess to what extent participants' ideas acknowledged the impact that the IT product could have for different stakeholders, I looked at how many stakeholders were mentioned by participants in their idea descriptions. As participants were only asked to explicitly list affected stakeholders next to each idea that they noted down in the second study iteration, we did not have any comparable data from the first study iteration. Therefore, I decided to investigate which stakeholders were mentioned by participants in the description of their ideas, which had been provided in both study iterations.

For this purpose, I first identified all relevant stakeholders that came up in the total pool of idea descriptions from all participants and case studies. Then, I conducted an automated search for each of the stakeholders (e.g., "biker" or "bikers") in the participants' original idea descriptions and created a variable that showed how often each stakeholder was mentioned per participant and idea. The resulting variable for acknowledged stakeholders that I used for a quantitative comparison of the technology roadmap and the ethics-based approach showed the number of stakeholders mentioned per participant and approach. I present a corrected version for the ethics-based approach, which does not take stakeholders into account that had been mentioned by the participant in an analysis before.

3.5.3. Net Value Effects and Standardized Net Value Effects

For a better understanding of the direction of value effects, that is, beneficial or adverse effects related to values and virtues that the participants had identified for the respective technological product or service, I developed the two measures *net value effect/s* (NVE) and *standardized net value effect/s* (NVE_s). NVE and NVE_s represent to what extent the number of positive and negative value effects identified by a participant deviate from a balanced number of positive and negative effects in absolute and relative terms. This is especially important when trying to explain why the participants opted for or against an investment in the product they had analysed (see Sections 4.3.2 “Anticipated Value Effects” and 4.3.3 “Value Effects Driving Decisions For/Against Investment” for results). In the following, I describe how I computed the two measures, what they express and how they differ.

I computed the net value effect by considering the absolute number of net positive or negative effects identified by a participant in each task (roadmapping, utilitarian analysis, virtue ethics analysis, deontological analysis), yielding

$$NVE = VE_p - VE_n,$$

where VE_p is the total number of value ideas of a participant describing positive effects and VE_n is the total number of value ideas of a participant describing negative effects. The standardized value NVE_s corrects the absolute number of net value effects NVE by relating it to the total number of ideas identified by the participant in each task, VE_T. This yields the following formula.

$$NVE_s = \frac{NVE}{VE_T} = \frac{VE_p - VE_n}{VE_p + VE_n}$$

The correction makes the net value effect more valid and ensures comparability across participants as the resulting values always lie between -1 (indicating that 100% of a participant’s ideas in a task described negative value effects) and 1 (indicating that 100% of a participant’s ideas in a task described positive value effects). Table 6 presents various examples. Example 7 shows that six identified positive effects and three harmful effects result in three net positive effects, $NVE = 6 - 3 = 3$. The standardized value in this example yields $NVE_s = \frac{6-3}{6+3} = 0.33$.

Table 6. Examples for net value effects and standardized net value effects

Example	VE_p	VE_n	VE_T	NVE	NVE_s
Example 1	0	10	10	-10	-1.00
Example 2	1	10	11	-9	-0.82
Example 3	5	10	15	-5	-0.33
Example 4	1	1	2	0	0.00
Example 5	8	7	15	1	0.07
Example 6	10	5	15	5	0.33
Example 7	6	3	9	3	0.33
Example 8	10	1	11	9	0.82
Example 9	1	0	1	1	1.00

Note. Examples 5, 7, and 9 described in the text are highlighted.

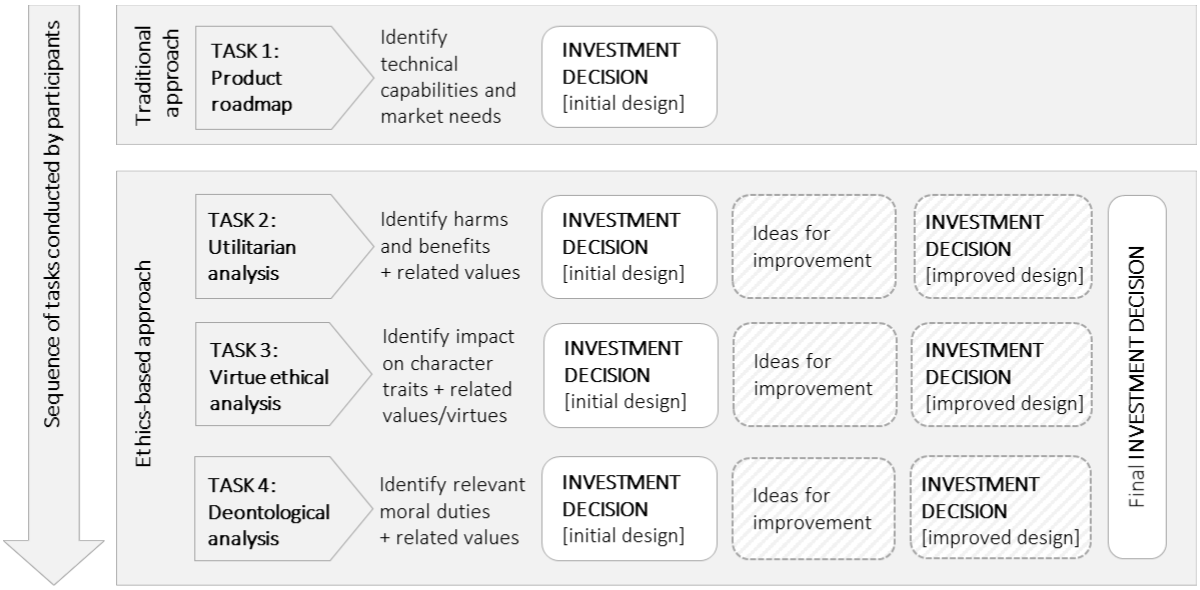
It is important to note that the standardized net value effect can be different for cases with the same net value effect, depending on the underlying number of positive and negative value effects. Examples 5 and 9 show that for an absolute net value effect of 1, the *standardized* net value effect is much higher in Example 9, where just one positive value effect was identified, $NVE_s = \frac{1-0}{1+0} = 1$, compared to the total of eight positive and seven negative value effects in Example 5, resulting in $NVE_s = \frac{8-7}{8+7} = 0.07$.

3.5.4. Investment Decisions

The number and nature of ideas mentioned by participants in the two innovation tasks do not express whether the person behind those ideas supports the envisioned product or not. Thus, participants were asked to additionally reflect on whether they would invest in the IT product and to explain their decision.

In the winter semester 2017, participants indicated their willingness to invest in the bike courier app or smart teddy bear described in their technology roadmap four times: 1) after the roadmap, 2) after the utilitarian analysis, 3) after the virtue ethics analysis, 4) after the deontological analysis, and 5) considering all three ethical analyses (“final investment decision”). In the winter semester 2018, participants working on the telemedicine platform were asked whether they would invest *twice* in each ethical analysis. Participants were first asked to base their decision at the end of an ethical analysis on the identified potential negative and positive value effects of the initial design of the telemedicine platform as captured in the roadmap. They made a second decision after coming up with ideas for how the product could be improved, addressing the value effects that they had identified and recommended in the respective ethical analysis, resulting in seven decisions. In addition, they were asked to make a final decision that should take all ethical issues and potentials into account as well as all related product improvements. In total, participants provided eight investment decisions for the telemedicine platform, see Figure 11.

Figure 11. Overview of innovation tasks and investment decisions



Note. Ideas for improvement and investment decisions regarding the improved design were only collected for the telemedicine platform.

To evaluate how the ethical analyses influenced the investment decisions, I first looked at the pattern of yes/no decisions. To answer RQ3.1, I compared decisions after the technology roadmap and decisions after the ethical analyses. Then, I addressed RQ3.2 by relating a participant's decision to invest or not to invest after each ethical analysis to the number of beneficial and harmful value effects that they had identified. I grouped participants for each investment decision in a *pro investment* and an *against investment* group and computed the means of the standardized net value effects for each group. To get a better understanding for motivations to invest or not to invest (RQ3.3), I analysed the reasons provided for the investment decisions in the second study iteration on the telemedicine platform. This data is only available for the telemedicine case. Together with the student project employee E.M., I conducted a qualitative analysis to extract common patterns in the participants' explanations for their investment decisions. Finally, I investigated whether they changed their decision when their suggested product improvements were included in the design of the respective IT product they had analysed to address RQ3.4.

3.6 Statistical Analyses

To answer RQ2 "How Do Ideas Generated by a Value-based Approach Compare to Ideas Captured in Traditional Technology Roadmapping?", I computed a statistical comparison of ideas captured in the technology roadmap and ideas from the ethics-based approach. This comparison was based on quantitative variables that showed the frequency of ideas related to the dependent variable of interest for each participant and approach. For example, the adverse effects variable represented the number of a participant's ideas expressing a negative effect for each analysis (roadmap, utilitarianism, virtue ethics, and deontology).

I statistically assessed the influence of the different approaches (technology roadmapping versus ethics-based approach), which formed the repeated measurements predictor variable, on each of the outcome variables, which comprised value fluency (RQ2.1) and fluency of product ideas (RQ2.2), value flexibility (RQ2.3), value originality (RQ2.4), adverse effects (RQ2.5), and considered stakeholders (RQ2.6). I entered the three IT products that the participants had analysed (bike courier app, smart teddy bear, telemedicine system) as additional predictor variables in the mixed factorial ANOVAs to control for the slight differences in set-up between the two study iterations and explore a potential influence of the investigated technology (RQ2.7). In a first comparison, I looked at the different impacts of the technology roadmap and the ethics-based approach on the outcome variables. To enable a more detailed understanding of the influence of each ethical perspective, I included the ethical analyses (utilitarianism, virtue ethics, and deontology) separately as predictor variables.

The creativity variables are based on the number of ideas per participant and analysis, which can assume the value zero in case a participant did not present any ideas in an analysis. The same holds for the number of beneficial/adverse effects and stakeholders acknowledged in a participant's idea descriptions. Thus, the dataset that represented the ideas from both innovation approaches described all participants completely and with the same number of repeated measurements, forming a complete data array. Also, creativity measures (fluency, flexibility and originality) formed continuous variables. As the participants conducted all analyses in pregiven sequence (technology roadmap, ethics-based approach with first a utilitarian, then a virtue ethics and last the deontological analysis), there was no randomization for the within-subjects independent variable. According to standard criteria, this does not allow the computation of a linear model such as an ANOVA. To mitigate this shortcoming, we decided to introduce a manual correction to the resulting data by excluding all ideas that a participant mentioned again in a later analysis. Through this procedure, we created variables that considered only new ideas that a participant had in the respective task. As this is not a standard procedure and can only partially account for possible effects resulting from the non-randomized order, I call for a cautious interpretation of the significant effects that I present below.

I assessed sphericity for each analysis. Where Mauchly's test of sphericity indicated a departure of sphericity, the Greenhouse-Geisser correction was used for departures < 0.75 and the Huynh-Feldt correction for values > 0.75. I used Bonferroni corrections for all post-hoc pairwise comparisons. As I am interested in how each of the outcome variables changes across the analyses, I report univariate results for each variable. All analyses were conducted with SPSS (version 23).

4 Results

In the following, I present the results from my mixed-method empirical study. Section 4.1 addresses RQ1 "How do the Perspectives of Different Ethical Theories Influence Value-based Thinking in Technology Design?" and presents empirical results that show how normative ethical theories such as utilitarianism, virtue ethics, and deontology can contribute an ethical foundation to the value elicitation phase in technology design. Section 4.2 addresses RQ2 "How Do Ideas Generated by a Value-based Approach Compare to Ideas Captured in Traditional Technology Roadmapping?". The results for all three value creativity parameters (fluency, flexibility, originality) show that the ethics-based approach inspired participants to consider new and diverse values that they had not thought of in the technology roadmapping task. What is more, the ethics-based approach also made the participants consider an extended set of product improvements while at the same time acknowledging potential negative effects for affected stakeholders. Finally, Section 4.3 seeks to answer RQ3 "How Does Value-Based Thinking Influence IT Investment Decisions?" by providing results on yes/no decision patterns across the different analyses and case studies, investigating the influence of potential value harms and benefits on the participants' decisions and exploring the qualitative reasoning that the participants had provided for each of their decisions.

The research questions and findings partly build upon each other (see Figure 1 for an overview). Most importantly, Section 4.1 explores whether ethical perspectives can indeed provide an ethical framing for the elicitation of values with moral import, and Section 4.2 then compares this ethics-based approach with a traditional IT innovation approach, i.e., technology roadmapping. Therefore, I do not only present the detailed empirical results in the respective subchapters, but also briefly discuss the results and the most important conclusions (see Sections 4.1.4, 4.2.8, and 4.3.4). The detailed discussion follows in Chapter 5 "Discussion and Outlook", where I discuss implications for research and practice as well as limitations of the empirical study.

4.1 How do the Perspectives of Different Ethical Theories Influence Value-based Thinking in Technology Design?

In this chapter, I present results showing that utilitarianism, virtue ethics, and deontology support the discovery of moral values in technology design. Based on the elaborate qualitative coding process and the resulting variables described in detail above, I answer RQ1 "How do the Perspectives of Different Ethical Theories Influence Value-based Thinking in Technology Design?" by exploring the resulting value ideas with regard to three aspects. First, I explore frequent and infrequent values to investigate whether utilitarianism, virtue ethics, and deontology facilitate the elicitation of particular values (Section 4.1.1). Second, I compare the share of instrumental versus intrinsic values and virtues to find out to what extent the different ethical perspectives capture morally high principles (Section 4.1.2). Third, I look at the underlying sustainability dimensions to see which areas for sustainable development are covered by the respective ethical perspectives (Section 4.1.3). In Section 4.1.4, I conclude that utilitarianism, virtue ethics, and deontology can be combined in practical settings such as the elicitation of values for a concrete technology design.

4.1.1. Frequent Values

Table 7 contains the details on frequent values found for each technology and ethical perspective. The pool of frequently elicited values showed a high sensitivity for the respective technology context, with very few overlaps across the three technologies. Still, some intrinsic values, e.g., privacy and health, reoccurred across the technologies and ethical theories. Generally, the three ethical value elicitation tasks differ in the type of values they emphasize.

Overall, the value elicitation task inspired by the utilitarian perspective triggered by far the highest number of ideas related to values (N=583; compared to 386 ideas in the virtue ethics and 295 ideas in the deontological analysis). This is not surprising, given that the utilitarian calculus invites to consider as many value effects as possible when weighing harms and benefits. However, when we look at the actually identified values and virtues (which can each subsume several ideas), the results of the three ethical perspectives are comparable in terms of their number (utilitarianism: 78, virtue ethics: 79, deontology: 74).

Table 7. Frequent values mentioned for each technology and ethical analysis

	Utilitarianism		Virtue ethics		Deontology	
	Value	*Freq.*	*Value*	*Freq.*	*Value*	*Freq.*
Smart teddy bear	Knowledge/education	83.3%	Kindness/friendliness	54.2%	Knowledge/education	58.3%
	Privacy	54.2%	Courage	45.8%	Privacy	62.5%
	Health	54.2%	Knowledge/education	37.5%	Safety	29.2%
	Safety	50.0%	Empathy, compassion	33.3%	Child-parent relationship	25.0%
	Child-parent relationship	45.8%	Caring (about people)	29.2%	Human contact	25.0%
	Friendship (machine-human)	33.3%	Determination/ambition	25.0%	Freedom	20.8%
	Productivity, profit	33.3%	Independence	25.0%	Independence	20.8%
	IT security	33.3%	Love	25.0%		
	Independence	33.3%	(Self-) discipline	20.8%		
	(More) Free time	29.2%	Responsibility/reliability	20.8%		
	Human contact	29.2%	Satisfaction/happiness	20.8%		
	Satisfaction/happiness	29.2%	Tolerance	20.8%		
	Environmental protection	25.0%				
	Personalization, customization	20.8%				
Bike courier app	Productivity, profit	66.7%	Responsibility/reliability	50.0%	Privacy	58.3%
	High quality service	58.3%	Determination/ambition	41.7%	Responsibility/reliability	25.0%
	Privacy	58.3%	Cooperation	41.7%	Health	25.0%
	Health	58.3%	Flexibility of the person	33.3%	Freedom	25.0%
	Satisfaction/happiness	50.0%	Courage	25.0%		
	Job positions & opportunities	41.7%	Kindness/friendliness	25.0%		
	Independence	41.7%	Punctuality	25.0%		
	Monetary benefits	33.3%	Commitment	25.0%		
	Efficiency & optimization	33.3%	Loyalty	25.0%		
	Errors/misunderstandings	33.3%				
	Time efficiency (service)	33.3%				
	Autonomy	25.0%				
	Belongingness	25.0%				
	Convenience	25.0%				
	Environmental protection	25.0%				
	Fairness	25.0%				
	IT security	25.0%				
	Novelty, diversity	25.0%				
	Safety	25.0%				
Telemedicine platform	Health	61.1%	Trust	55.6%	Health	55.6%
	Efficiency & optimization	55.6%	Truthfulness, honesty	50.0%	Privacy	55.6%
	Privacy	50.0%	Commitment	50.0%	Equality	27.8%
	Accuracy	44.4%	Patience	44.4%	Truthfulness, honesty	27.8%
	Accessibility	33.3%	Empathy, compassion	44.4%	Efficiency & optimization	22.2%
	Knowledge/education	33.3%	Considerateness	33.3%	Dignity	22.2%
	Productivity, profit	33.3%	Excellence	33.3%	Fairness	22.2%
	Truthfulness, honesty	33.3%	Cooperation	22.2%	Human contact	22.2%
	Comfort	27.8%	Corruptibility	22.2%	Self-care	22.2%
	Fairness	27.8%	Courage	22.2%	Time efficiency (service)	22.2%
	Trust	27.8%			Transparency	22.2%
	IT security	22.2%			Trust	22.2%
	Transparency	22.2%				
	Visibility & reputation	22.2%				

Note. The column "Freq". shows the percentage of participants that mentioned value (cut-off: 20% of participants); Highlights in colour show overlaps between ethical analyses for each technology case.

Utilitarianism seems to be good at capturing the central values that the respective technology is designed to foster: most participants mentioned productivity/profit for the bike courier app, knowledge/education for the smart teddy bear, and health for the telemedicine platform. At the same time, some values re-appear as prominent values in the utilitarian analysis across all three technologies: health, privacy, and productivity/profit were mentioned by at least one third of the participants. In the following, I discuss their seemingly universal relevance and easy accessibility in a technology design task observed across the three case studies, which motivate their classification as mainstream values (Spiekermann, 2016; see also the related discussion in the Introduction and Section 2.5.2). Looking at the literature, it appears that all three values are common values that have relevance beyond the three case studies that I cover. Privacy was mentioned by at least half of the participants for all three technologies. Due to numerous reported data breaches and rising public concerns about health and location information, privacy has become a mainstream area of research in the past years (Yun et al., 2019), which makes it an obvious candidate for a mainstream value. Privacy is also represented as an ethical principle in more than half of the policy documents for ethical AI development that Jobin et al. (2019) reviewed. The value health holds a comparably prominent place among the frequently mentioned values from the utilitarian perspective for all three technologies. This is in line with recent empirical research on values in design, which reported health as the most important value for participants with different cultural backgrounds (Kheirandish et al., 2020). The third value that was mentioned across all three technologies in the utilitarian analysis is productivity/profit. This might be based on the fact that the participants were students of economics and business who have productivity and profit as a company's primary goal in mind and turn it into a mainstream value when analysing a technological product or service.

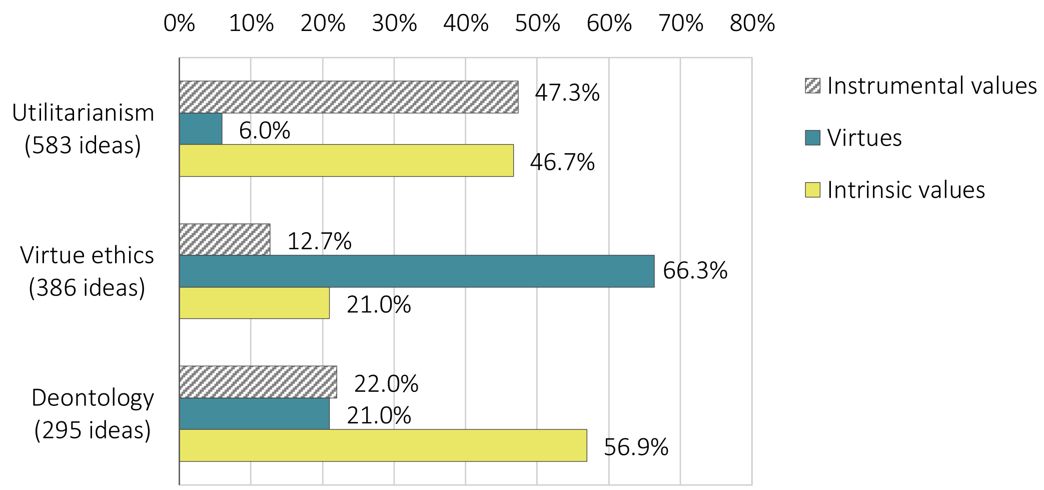
In the deontological analysis, the participants re-embraced some values discovered in the utilitarian analysis. For example, more than half of the participants again mentioned the mainstream value privacy in the deontological analysis. Value elicitation from a deontological perspective thus runs the risk of promoting duties mechanically by repeating values that everyone talks about (e.g., in the media) instead of values that represent principles that one needs to adhere to out of moral duty (Kant 1785/2011). That said, the participants did not repeat all prominent values from the utilitarian analysis. For example, the instrumental economic value "productivity/profit" was not among the frequent values of the deontological analysis. What is more, the deontological analysis also regularly led the participants to identify intrinsic values not often mentioned in any of the other two ethical analyses, such as freedom, equality, or the risk of losing human contact. It seems that the Kantian focus supported the participants in moving away from business goals and towards the consideration of high moral principles that are universally relevant. Thus, in spite of the potential pitfall to repeat easily available values, deontology still contributes a unique ethical perspective inherent in the moral reasoning of the Categorical Imperative.

The virtue ethics perspective yielded fewer mainstream values, probably because a technology's character effects are rarely discussed in today's public (technology) discourse. Virtues mentioned by at least half of the participants included the reliability of bike couriers that can be fostered through the constant usage of a time-sensitive app, the kindness of children that might be promoted through the smart teddy bear's polite form of conversation, and the commitment of patients to their personal healthcare supported by a telemedicine platform that is easier to access than a physical medical practice. The virtue ethics analysis also inspired more nuanced reflections about virtue: the bike courier's potential loss of a healthy ambition resulting from a lack of human interaction, the child's loss of courage due to the ubiquitous presence of its digital companion, or a doctor's increased considerateness due to extended video sessions with patients.

4.1.2. Intrinsic Values, Instrumental Values and Virtues

Figure 12 shows an overview of the pool of ideas elicited by the respective ethical theories and aggregated for all three technologies. Appendix F shows separate results for the bike courier app (Figure F2), the smart teddy bear (Figure F2), and the telemedicine platform (Figure F3).

Figure 12. Share of instrumental/intrinsic values and virtues among the pool of value ideas aggregated for the three technologies



As outlined above, the participants identified instrumental values, intrinsic values, and virtues. In line with the philosophical reasoning behind each of the ethical perspectives, the three category groups vary significantly in their prominence for the utilitarian, virtue ethics and deontological analysis.

The utilitarian perspective clearly elicited the greatest share of instrumental values (47.3%) compared to virtue ethics (12.7%) and deontology (22%). This relates well to general utilitarian reasoning because values such as efficiency and productivity cater to the utilitarian good. That said, Figure 12 shows that utilitarian reflections have also led to the identification of many intrinsic value ideas (46.7%). This finding might have resulted from the general utilitarian study set-up, which invited the participants to consider the consequences of *everyone* acting in the same manner in a specific situation instead of directing the participants to focus only on *their* own actions in a specific situation (act utilitarianism) or on *rules* (rule utilitarianism). This might have inspired the participants to think about values that are highly relevant for everyone and hence cater to intrinsic values such as health and knowledge/education. Mill's call for maximizing the good for the greatest number of people also came up regularly in the value satisfaction/happiness which was mentioned most often in the utilitarian analysis.

That said, deontological reflections elicited the highest share of intrinsic value ideas (56.9%), in line with the deontological focus on universal principles. Most importantly, the participants named values that had not been captured in the other analyses, such as personal growth in the cases of the bike courier app and the smart teddy bear, or the development of society in the telemedicine case. In other words, the deontological focus seems to have successfully inspired the participants to think about values of higher rank and universal applicability during the value elicitation process.

The virtue ethics perspective naturally inspired the participants to come up with ideas linked to virtues (66.3%). A total of 44 out of the 47 different virtues (93.6%) identified by means of the three ethical questions were uncovered by the virtue ethics analysis (ranging from 80.8% to 100% for the three technologies).[6] The participants' reflections described how stakeholders' virtuous character traits and habits could be *affected by* the technology (e.g., the bike courier's increased flexibility and punctuality due to the use of an app) on the one hand, and that virtues

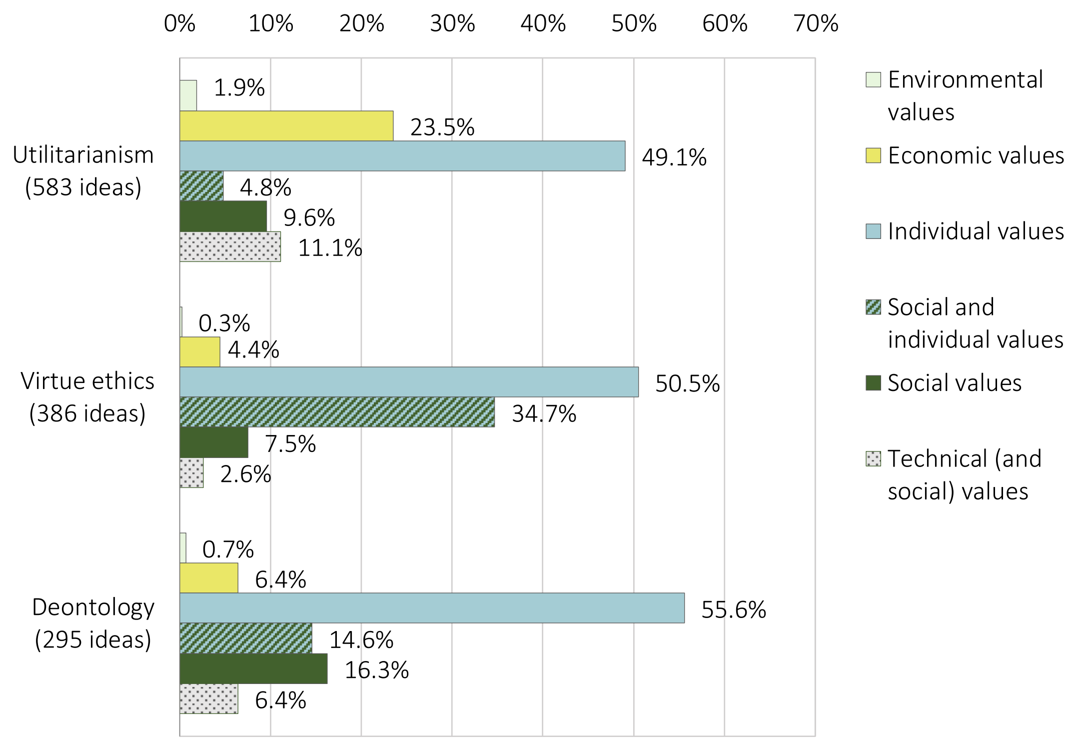
[6] The number of virtues does not coincide with the number of ideas referring to a virtue as several ideas, even by one participant, might refer to one and the same virtue and only describe different nuances.

could *affect* how the technology plays out for a certain stakeholder and use context (e.g., a doctor's commitment, patience, or excellence when using the telemedicine platform) on the other hand. Furthermore, 21.0% of the ideas uncovered by the virtue ethics perspective related to intrinsic values important for individuals, such as trust, knowledge/education, or independence.

4.1.3. Sustainability Dimensions

The pool of value ideas aggregated for all three technologies and categorized according to their underlying sustainability dimension (Figure 13) shows that in all three ethical perspectives around half (49.1–55.6%) of the value ideas represented *individual* values. Individual values include values like convenience or health and virtues like frugality or perseverance, all of which cater to an individual's well-being. In comparison, the identified *social* values covered only 10.5% of the ideas, which shows an emphasis on individual development and well-being and a neglect of societal development, social welfare and mutual care, which the virtue ethics perspective could only partially mitigate (yielding 34.7% social and individual values). Appendix F shows the results separately for the bike courier app (Figure F4) the smart teddy bear (Figure F5), and telemedicine platform (Figure F6).

Figure 13. Sustainability dimensions underlying value ideas for all three technologies



Health, privacy, knowledge/education, satisfaction/happiness, safety, and independence cover almost half (49.1%) of all individual value ideas and represent intrinsic values that are morally relevant. Still, it is remarkable that the participants' ideas related to individual values almost *five times* as often as to social values. This finding resonates with MacIntyre's (1981/2007) criticism of individualistic moral thinking in modern societies and leads to speculate whether current generations are at all capable of appreciating the moral difference between individualistic and social virtues and to perceive the higher moral relevance of the social. MacIntyre heavily criticized the predominant focus on the individual in moral questions, arguing that we should draw on classic moral philosophy to correct this flawed modern understanding of ethics and that we should rediscover the importance of virtue as a social practice. The empirical findings provide only partial support for MacIntyre's claim: half of the ideas in the virtue ethics analysis showed the same individual focus as the other ethical perspectives. Still, virtue ethics also inspired around twice as many socially related value implications as the utilitarian perspective (virtue ethics: 163, utilitarianism: 84), as well as the highest number of ideas with a combined individual and social relevance, as discussed in more detail below.

A second important finding is that all three ethical perspectives failed to inspire value ideas that relate to the natural environment. Only one environmental value was detected by the utilitarian analysis in the bike courier app, where a greener city was envisioned if bikes instead of cars delivered food. This is a meagre result at a time when environmental discussions are omnipresent because of the climate crisis we're facing. The participants could have raised concerns about the waste created when analogue products are digitalized as in the case of the smart teddy bear, or the CO_2 emissions caused by AI implementations. Yet, it has often been argued that the general focus of traditional ethical theories has never been so much on the natural environment as on human beings and their moral development—traditional ethical theory is anthropocentric (Jonas, 1984; Russ, 2019; Shearman, 1990). However, this result is unsettling, as it suggests that even the combination of three (traditional anthropocentric) ethical theories can fail to see one of the most pressing societal values, that is, the depletion and destruction of natural resources.

Delving into further nuances foregrounded by the three ethical frameworks, the utilitarian perspective turned out to be best to capture *economic* and *technical* values. The entanglement of utilitarian theories with economic history and concepts such as utility and maximization could explain why the participants often thought of how the company could increase its productivity, efficiency, and reputation by producing the technology assessed. Among the technical value ideas, IT security came up most often. The participants also mentioned values that concerned *technical* and *social* dimensions, such as the accessibility of the telemedicine platform for elderly and handicapped users. That said, the utilitarian analysis also uncovered some *social* values. For example, the participants identified a potentially negative value implication of the bike courier app regarding human contact, or of the smart teddy bear regarding the child-parent relationship. To summarize, the utilitarian perspective led to the highest number of ideas, as well as the most diverse value spectrum.

Results show that even the direct reference to virtue ethics could not shift the participants' thinking towards prioritizing the social implications over the individual, which—according to MacIntyre (1981/2007)—would be of higher moral relevance. Contrary to MacIntyre's assumption, the virtue ethics analysis led the participants to identify more virtues with a primary relevance for the individual (e.g., courage or patience) than virtues that are clearly based on individuals interacting with their social environment (e.g., empathy or kindness). Still, the virtue ethics perspective clearly inspired the participants to focus on the development of individuals, an aspect at the core of the Aristotelian moral theory that is largely missing in the values identified in the utilitarian analysis. Consider for instance privacy and convenience, which benefit an individual but, in contrast, not depend on the person's moral development.

Also, the virtue ethics perspective helped to elicit the highest share of ideas on virtues and values that combine *individual and social* relevance. The participants mentioned bike couriers' kindness/friendliness, children learning to care for both the smart teddy bear and for other people, but also thought of doctors' truthfulness/honesty and empathy/compassion towards patients they treated through telemedicine. This fits with the Aristotelian view that virtues are bound to an individual but are beneficial in the social context, i.e., the community. For example, a person who is kind or honest can neither develop nor express the underlying virtue without a social environment. For this reason, there is a special moral relevance in this combined value category.

Value elicitation from a deontological perspective inspired the participants to re-emphasize previously mentioned *technical* (e.g., "IT security") and *economic* values (e.g., efficiency & optimization) as personal maxims. Such an emphasis could be interpreted as empirically supporting Hannah Arendt's critique that contemporary norms and principles are often misinterpreted as Kantian principles. However, a wide approval of principles is neither necessary nor sufficient for a qualification as a moral principle: from a Kantian perspective, moral principles are grounded in the categorical imperative, which emphasizes reciprocity and universality. Still, we also see that deontology takes social values into account, with a focus on intrinsic values such as equality, fairness, friendship and love. While this can only be observed tendentially, the underlying shift to socially relevant values inspired by an ethical perspective that emphasizes moral duty is considerable.

4.1.4. Conclusion: A Pluralist Ethical Foundation for the Value Elicitation Process

If values can represent what is good and morally desirable, any perspective on what is good and morally desirable could, in theory, be able to contribute a unique angle to the analysis of social and ethical implications of a technology in terms of values. While I have discussed above the difficulties of combining competing philosophical theories (see Section 1.2.1), I want to borrow theoretical arguments for the combination of ethical perspectives from Mingers' (2001) argumentation for combining research methods in the field of information systems (p. 243). First, different ethical perspectives focus on and thus generate information about “different aspects” of morality. Therefore, a “richer and more reliable” understanding of a technology’s moral impact can be gained by “combining” several ethical perspectives in the design process of the respective technology. Second, ethical theories are “constructs of our thought” and can never match the world that we live in, which “is almost certainly more complex than we do, or possibly can, know”. Thus, while specific ethical theories seem “incommensurable”, and mixing them seems to be “logically incoherent”, it is possible to “detach” the basic reasoning of an ethical theory “critically and knowledgeably” in order to combine it with the aim of generating rich information on a moral issue. Based on results of the empirical investigation, I clearly see evidence for combining ethical perspectives in a pluralist ethical basis for the value elicitation process. My findings suggest that such an ethics-based value elicitation can help to identify values that represent potential consequences of a technology for stakeholders but also strengthen the adherence to duties and the development of virtues of stakeholders interacting with the technology.

The classical utilitarian approach, focusing on the good for the largest number, inspired the highest absolute number of both instrumental and intrinsic value ideas with the preponderance of individual and economic values. It inspired instrumental values with a special focus on economic and technical sustainability but also intrinsic values such as well-being. It also helped to identify technical values such as IT security or ease of use that need to be supported by a technology in order to foster higher values (e.g., satisfaction/happiness). Such values cannot be identified through the virtue ethics perspective, which focuses on the person and the potential impact of the technology on social interactions. At the same time, the utilitarian perspective does not consider the impact on the moral development of individuals within their social environment. It was also especially prone to capturing obvious values that represent central themes of a technology, universally acknowledged principles, or timely discourses. This is in line with the criticism brought forward by Umbrello (2020b), who pointed out that traditional moral theories only work well for “prototypical” cases but fail to address the “peripheries” of moral concepts and issues (p. 582). Results show that a virtue ethics perspective crucially complemented the utilitarian focus by emphasizing individual growth and personal development, acknowledging the intersection of individual and social values that the utilitarian focus had neglected.

Virtue ethics, in turn, anticipated potential issues that would have been ignored by the utilitarian analysis, such as a deterioration of doctors’ patience when having to treat even more patients assigned to them through the telemedicine platform, or potentials that could further improve the doctor’s excellence. Virtues have been suggested as the basis for a technology design method that tries to discover ways in which a technology supports or obstructs the cultivation of virtues (Reijers & Gordijn, 2019). Thus, the integration of a virtue ethics perspective in value-oriented research seems justified, although I have pointed out an overall individualistic bias in the participants’ value ideas.

Deontology helped to re-emphasize important values identified in both the utilitarian analysis (e.g., IT security) and the virtue ethics analysis (e.g., truthfulness/honesty) but also confirmed its own unique focus, e.g., on intrinsic values such as equality or personal growth. The deontological analysis resulted in the highest proportion of intrinsic values and value ideas that relate to social sustainability, such as equality or freedom. It elicited ideas that are surprisingly diverse, mirroring the pluralist view of duties suggested by Ross (1930).

With these different contributions, each ethical theory serves a unique role in the identification of issues and potentials of IT products. Thus, choosing one perspective over the other for technology design needs to be well argued as this is most likely to result in specific value aspects being ignored or neglected. Because of their unique foci, I clearly see evidence for the potential of combining the ethical perspectives in the elicitation of value ideas, as proposed by VBE (Spiekermann, 2016, 2023). The use of different ethical perspectives can provide an ethical foundation for technology design ideas and thus improve the ethical constitution of technologies for people that are directly affected as well as for society as a whole.

4.2 How Do Ideas Generated by a Value-based Approach Compare to Ideas Captured in Traditional Technology Roadmapping?

To answer RQ2 "How Do Ideas Generated by a Value-based Approach Compare to Ideas Captured in Traditional Technology Roadmapping?", I combined the qualitative analysis of the participants' ideas with a quantitative comparison. I investigated the effects that participants anticipated for various stakeholders and determined the participants' creativity in value thinking based on the three creativity parameters fluency, flexibility and originality. To stress that the value-based approach that participants employed combined the ethical analysis of the respective IT product from three ethical perspectives (see Figure 9 and Table 2 above for an overview and the detailed instructions), I use the term "ethics-based approach" to differentiate it from the technology roadmapping approach.

Based on the bike courier application, the smart teddy bear, and the telemedicine system, results show that the participants' creativity to come up with value ideas dramatically increased when they engaged in ethics-based thinking. Taking different ethical perspectives inspired the participants to come up with more than three times as many value ideas (see value fluency, Section 4.2.2) and enabled them to be more flexible (Section 4.2.4) and original (Section 4.2.5) in their thinking about values that they consider relevant for the respective technology context. While the three value creativity parameters only acknowledge the participants' ideas that were classified as value ideas, Section 4.2.3 shows that the ethics-based approach also led to an additional set of product characteristics that the participants came up with. What is more, the ethics-based approach helped to anticipate potential negative implications for a broader range of affected stakeholders, contributing to better ethical foresight. In order to assess acknowledged stakeholder effects, I examined the number of adverse effects (Section 4.2.6) as well as the number of stakeholders that the participants mentioned in their idea descriptions (Section 4.2.7), including those ideas that were not classified as value ideas. In Section 4.2.8, I summarize and discuss these results.

4.2.1. Overview of Results

In total, the participants came up with 1,310 ideas in the first study iteration, 394 of them for the bike courier app and 916 for the smart teddy bear, of which the technology roadmap yielded only 24.4% (bike courier app) and 26.2% (smart teddy bear) of the totality of ideas, respectively. In the second study iteration, the teams came up with 809 ideas for the telemedicine system, of which 38.6% resulted from the technology roadmap. Table 8 and Table

9 provide descriptive statistics for all parameters. The statistical effects from the ANOVAs are shown in Table E1 in the appendix. In the following, results related to value creativity are based on the comparison of only those ideas which related either to values or virtues (value ideas).

Table 8. Mean number of ideas in the technology roadmap

	Bike courier app (*N* = 12)			Smart teddy bear (*N* = 24)			Telemedicine system (*N* = 18)			Total (*N* = 54)		
Parameters	Mean	*SD*	SE	Mean	*SD*	SE	Mean	*SD*	SE	Mean	*SD*	SE
Fluency	3.92	1.88	0.54	4.37	1.91	0.39	7.72	6.92	1.63	5.39	4.52	0.62
Product ideas corr.	8.00	3.28	0.95	10.00	3.89	0.79	17.33	10.44	2.46	12.00	7.67	1.04
Flexibility	1.75	0.62	0.18	1.96	0.62	0.13	2.50	1.10	0.26	2.09	0.85	0.12
Originality	0.21	0.16	0.04	0.35	0.11	0.02	0.30	0.10	0.02	0.30	0.13	0.02
Stakeholders	1.42	1.38	0.40	1.58	1.25	0.25	3.94	1.80	0.42	2.33	1.85	0.25

Note. Participants did not identify any adverse effects in the technology roadmap, which is why this variable is not included in the table.

Table 9. Mean number of ideas in the ethics-based approach

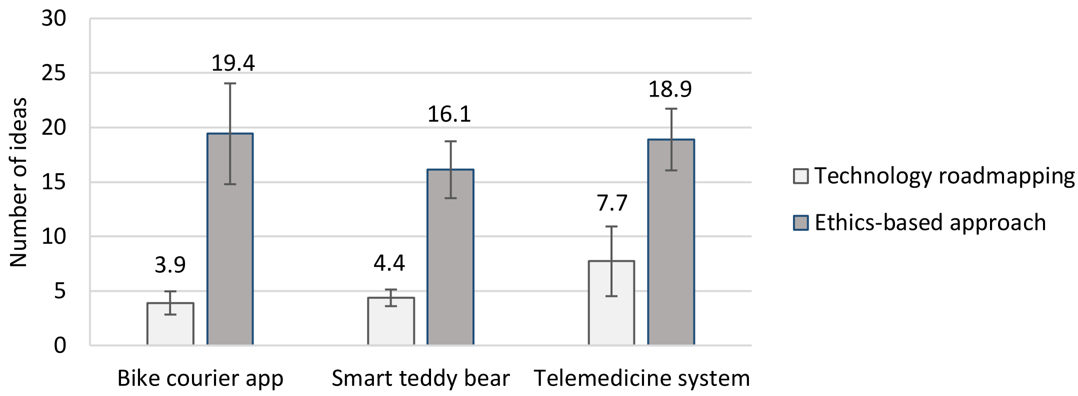
	Bike courier app (*N* = 12)			Smart teddy bear (*N* = 24)			Telemedicine system (*N* = 18)			Total (*N* = 54)		
Parameters	Mean	*SD*	SE	Mean	*SD*	SE	Mean	*SD*	SE	Mean	*SD*	SE
Fluency corr.	19.42	8.17	2.36	16.12	6.52	1.33	18.89	6.13	1.44	17.78	6.83	0.93
Product ideas corr.	13.42	7.46	2.15	16.49	11.18	2.28	42.44	28.38	6.69	24.44	22.15	3.01
Flexibility corr.	4.42	0.79	0.23	4.08	1.28	0.26	4.50	0.92	0.22	4.30	1.08	0.15
Originality corr.	0.59	0.07	0.02	0.62	0.09	0.02	0.58	0.06	0.01	0.60	0.07	0.01
Adverse effects corr.	10.08	4.46	1.29	10.13	4.14	0.85	9.83	4.55	1.07	10.02	4.27	0.58
Stakeholders corr.	6.25	2.38	0.69	4.50	2.00	0.41	4.67	1.94	0.46	4.94	2.15	0.29

Note. "corr." indicates that the variables are based only on ideas that had not been mentioned by the participant before

4.2.2. Fluency of Value Ideas

The first investigated creativity aspect looks into whether an ethical framework fosters or hinders creative thinking around values. Results show that the ethics-based approach inspired a higher number of new value ideas than technology roadmapping, see Figure 14.

Figure 14. Means with 95% confidence intervals for corrected fluency of value ideas

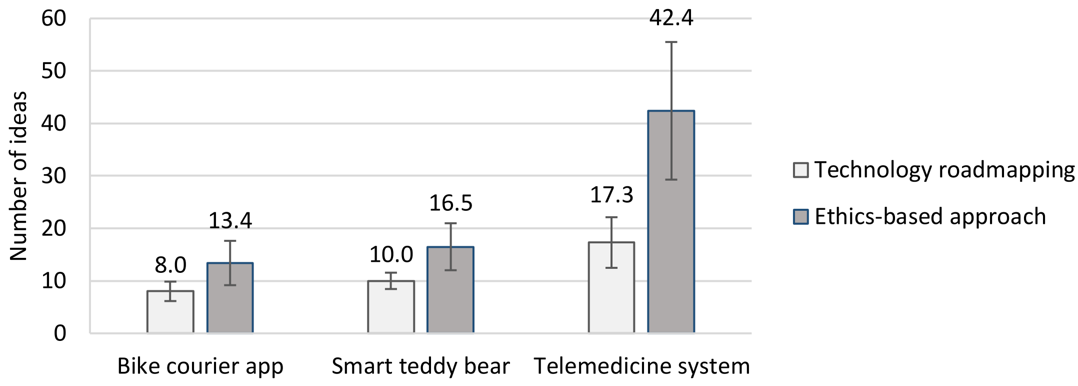


The results show that in the technology roadmapping approach, the participants went beyond the mere identification of product characteristics (which amounted to 55.1% of their ideas) and also mentioned or implied values (44.9%). More concretely, the participants came up with an average of five value ideas in the roadmap (M = 5.39, SD = 4.52). This compares to 18 *additional* value ideas in the ethics-based approach (M = 17.78, SD = 6.83), that is, new value ideas that the participants had not mentioned before in the roadmap. A total of 85.9% of the ideas resulting from the ethics-based approach referred to values and virtues that could and should be considered when launching the IT product. A closer investigation of the different ethical perspectives shows that the participants came up with the highest number of ideas in the analysis inspired by utilitarianism (M = 9.33, SD = 4.16) and the lowest number of ideas in the deontological analysis (M = 2.50, SD = 1.92; virtue ethics: M = 5.94, SD = 2.94). Results of the statistical analyses support the assumption that the two innovation approaches had a highly significant influence on value fluency, $F(1, 51) = 138.22$, $p < 0.001$, $\eta^2 = 0.73$.

4.2.3. Fluency of Product Ideas

On average, the participants came up with 12 product characteristics (M = 12.00, SD = 7.67) in the technology roadmap compared to 24 additional product characteristics (M = 24.44, SD = 22.15) in the ethics-based approach. This difference in the number of product ideas was significant, $F(1, 51) = 26.26$, $p < 0.001$, $\eta^2 = 0.34$. Only *new* product characteristics derived in the ethics-based approach are considered here, excluding ideas that a participant had enlisted in the technology roadmap before. Answering RQ2.2, the data highlights the immensely positive influence ethical theories can have on the generation of product ideas (see Figure 15).

Figure 15. Means with 95% confidence intervals for corrected number of product ideas

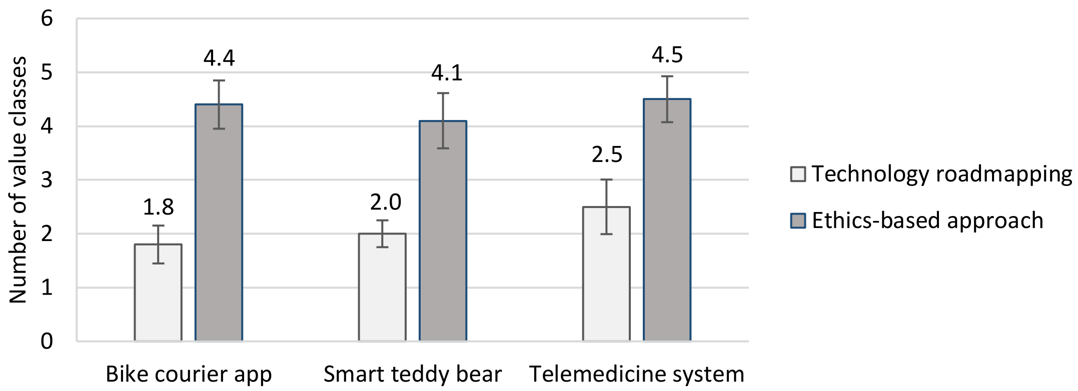


When the different ethical perspectives are considered separately, data shows that the utilitarian reflection alone (M = 12.17, SD = 9.88) inspired as many unique product ideas as the entire technology roadmapping exercise, followed by seven additional ideas from virtue ethics (M = 6.81, SD = 7.52) and five from deontology (M = 5.46, SD = 6.66). The product under investigation had an influence on the fluency of product ideas, with the telemedicine system showing a significantly higher output in terms of product ideas than the other two IT products ($p < 0.001$). The interaction of product and innovation approach was significant ($p = 0.001$), as the telemedicine system also showed a more pronounced increase of ideas in the ethics-based approach compared to the other two IT products (see Figure 15).

4.2.4. Flexibility of Value Ideas

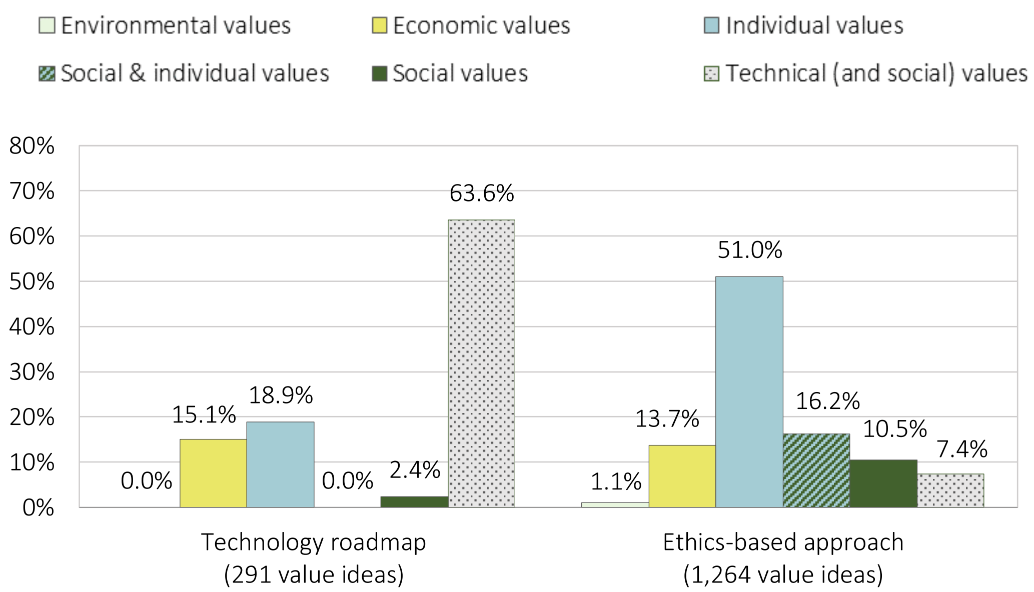
To assess the participants' creative flexibility, I looked at the number of value classes (i.e., sustainability dimensions) that a participant's value ideas spanned. A participant's value ideas covered on average two sustainability dimensions in the technology roadmap (M = 2.09, SD = 0.85; the participants mostly focused on technical, economic or individual sustainability) compared to five sustainability dimensions when the ethics-based approach was applied (M = 4.59, SD = 1.07), see Figure 16. Figure 17 shows that the sustainability dimensions were more equally distributed across the pool of value ideas in the ethics-based approach. Results of the ANOVA indicate that the innovation approach had a significant influence, $F(1, 51) = 202.76$, $p < 0.001$, $\eta^2 = 0.80$. The specific IT product under investigation had no significant influence on creative flexibility.

Figure 16. Means with 95% confidence intervals for corrected flexibility (= number of value classes covered)



Looking into the nature of this thought-flexibility, it is noteworthy that both innovation approaches uncover economic values such as "efficiency", "high quality service", "job positions & opportunities", etc. Due to its higher fluency, the ethics-based approach yields more economic value potentials in absolute terms (173 value ideas compared to 44), while the relative creative flexibility on this economic dimension is comparable for the two approaches (15.1% of all value ideas in technology roadmapping compared to 13.7% in the ethics-based approach).

Figure 17. Distribution of value classes among all value ideas aggregated from the three IT products

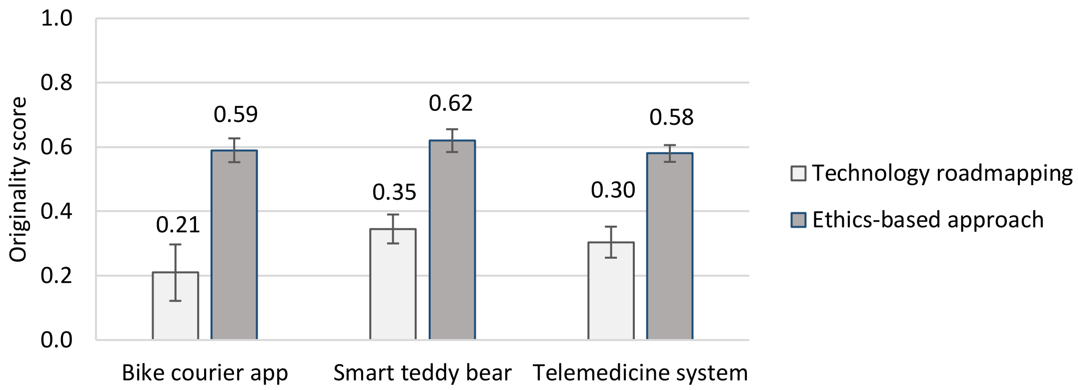


Technical values, however, show the expected difference: 61.9% of the value ideas reported in the roadmapping exercise are of a technical nature as opposed to 4.7% in the ethics-based approach. Thus, ethics-based thinking seems to shift the focus away from values that technologies can carry, such as ease of use, IT security, durability, ease of maintenance, etc., and opens up creative flexibility to consider social and individual values that the product caters to or undermines. Consider, e.g., *social values* such as community, charity, cooperation, family and human contact (e.g., between bike couriers), which make up 10.5% of the value ideas generated in the ethics-based approach but are hardly recognized in technology roadmapping (only 2.4% of value ideas). In addition, ethics-based planning sees more *individual values* impacted by the technologies (51.0%) than technology roadmapping (18.9%). Values such as a gain in flexibility, free time, and control, but also potential losses of control or a rise in corruptibility are more likely to be recognized when using an ethics-based approach. An average participant spotted only *one* individual value through technology roadmapping, such as the mainstream value of individual safety in the case of the smart teddy bear. Finally, what seems to be a weakness of both approaches is that environmental values are not at all recognized by technology roadmapping and only in a very limited way in the ethics-based approach applied here (1.1%).

4.2.5. Originality of Value Ideas

To assess value originality, I looked at the rarity or infrequency of value ideas provided by individual participants for each IT product. The technology roadmap approach resulted in a mean originality score of 0.3 ($M = 0.30$, $SD = 0.13$), whereas the ethics-based approach yielded a mean originality score of 0.6 ($M = 0.60$, $SD = 0.01$). These numbers signal that an average idea from the technology roadmap was mentioned by 70% of all participants (0.70 = 1 – 0.30). Representative value ideas for this level of originality are efficiency & optimization for the telemedicine system and the bike courier app and ease of use for the smart teddy bear. On the other hand, an average idea yielded in the ethics-based approach was more original, with less than half of the participants thinking of it (0.40 = 1 – 0.60). Representative examples here are patience in the telemedicine case, human contact for the smart teddy, and job positions & opportunities for the bike courier app. This difference in originality was significant according to the conducted ANOVA, $F(1, 51) = 278.46$, $p < 0.001$, $\eta^2 = 0.85$. The interaction effect of product and approach was also significant, with a more pronounced increase in original ideas when the ethics-based approach was used with the bike courier app than in the other two cases (see Figure 18).

Figure 18. Means with 95% confidence intervals for corrected originality scores



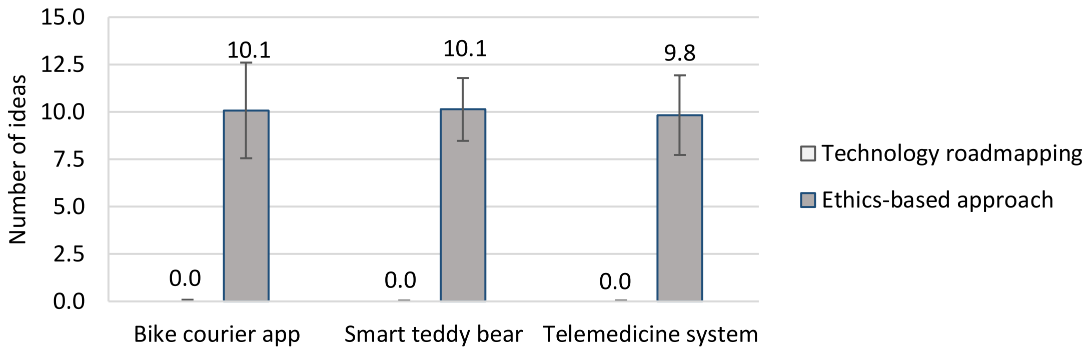
Looking at the three ethical analyses in the ethics-based approach, ideas with higher originality resulted from the virtue ethics analysis ($M = 0.67$, $SD = 0.10$) and deontology ($M = 0.69$, $SD = 0.22$), compared to utilitarianism ($M = 0.54$, $SD = 0.12$). This shows that varied dimensions of human character and behaviour such as gratefulness and tactfulness (each mentioned by less than 10% of the participants) represent unique ideas in product innovation. In contrast, the technology roadmap inspired more common ideas; for instance, ease of use was mentioned by at least 75% of the participants. Across the three IT products, IT security was the most frequent value idea.

4.2.6. Anticipated Adverse Effects

In the technology roadmap, the participants neutrally listed what the product or service should be made up of: more than half of the technology roadmapping ideas (55.1%) were coded as neutral product characteristics (e.g., scheduling function or search engine for information). At the same time, 44.9% of the ideas contained a positive value of the technology (e.g., ease of use, IT security, or efficiency & optimization) or a beneficial effect for the stakeholders (e.g., patients' hopefulness to receive a good and fast treatment).

Figure 19 shows the mean number of harmful effects reflected in all participants' ideas. The participants did not acknowledge any potential adverse effects when they employed technology roadmapping. On the other hand, the ethical evaluation based on utilitarianism, virtue ethics, and deontology resulted in an average of 10 potential adverse effects ($M = 10.02$, $SD = 4.27$). For example, the participants thought of privacy issues, but also reflected on the stakeholders' emotional well-being when adding exhaustion and the feeling of powerlessness as well as other abilities and conditions that are affected. They mentioned the risk of a decreased awareness and attention of the bike couriers as well as the child's creativity that is held back when constantly playing with a digital toy. These considerations from ethical perspectives are mirrored in the significant main effect of the technology roadmapping vs. ethics-based approach on the number of ideas acknowledging adverse effects, $F(1, 51) = 263.88$, $p < 0.001$, $\eta^2 = 0.84$. Based on these findings, technology roadmaps seem to support an overly optimistic view of technological advancements. A closer look at each of the three ethical perspectives shows that they identified beneficial and adverse effects in a roughly balanced way, while they rarely led to neutral ideas.

Figure 19. Means with 95% confidence intervals for corrected number of ideas describing adverse effects



4.2.7. Considered Stakeholders

I also looked into how many stakeholders a participant mentioned in their idea descriptions. Table 10 presents the full list of stakeholders that I identified in the participants' descriptions of ideas and shows that the ethics-based approach supported the participants in identifying additional stakeholders that they had not considered in the technology roadmap.

While some stakeholders were mentioned for all three IT products, e.g., customers, the company, but also friends and the environment, other stakeholders were more context-specific. For example, bikers and restaurants were prominent stakeholders in the bike courier app, children and parents were often mentioned for the smart teddy bear, and doctors and patients were relevant only for the telemedicine platform. Interestingly, the ethics-based approach inspired the participants to think not only of specific stakeholders such as the siblings of the child playing with the smart teddy bear, but also of traditional stakeholders in the business setting such as shareholders, managers, the company, and customers.

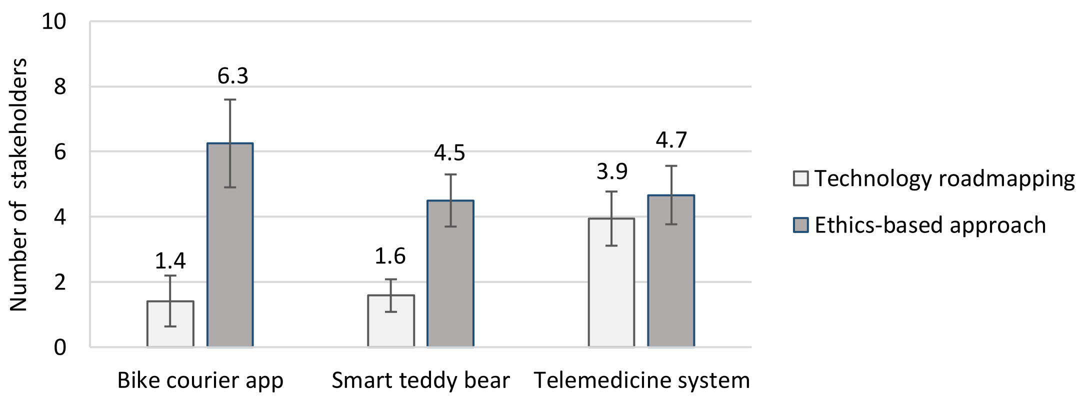
Figure 20 shows the mean number of mentioned stakeholders for the two approaches and all three IT products. As technology roadmapping was conducted first and the ethics-based approach afterwards, I controlled for all overlaps by not counting stakeholders in the ethics-based analysis that the participants had already mentioned in the technology roadmap.

Table 10. Stakeholders mentioned in the participants' idea descriptions

IT product	Stakeholders mentioned in both approaches	Stakeholders mentioned only in the ethics-based approach
Bike courier app	• Bikers • Customers • Restaurants • Users • Friends	• Society/public, People/everyone, Communities • Company, Competitors, Shareholders, Employers, Managers, Employees, Colleagues • Family • Environment
Smart teddy bear	• Children, Parents, Friends • Users • Environment • Managers	• Society/public, People/everyone, Communities • Government • Company, Shareholders, Customers, Employees • Family, Siblings, Teachers
Telemedicine platform	• Doctors • Patients • Users • Company, Competitors, Customers, Managers • Friends • Parents, Children • Hospitals, Insurance companies • People/everyone • Environment	• Society/public • Colleagues • Communities • Shareholders • Employers • Family

Note. Related stakeholders are shown together in one bullet point (e.g., children and parents)

Figure 20. Means with 95% confidence intervals for corrected number of mentioned stakeholders



On average, the participants mentioned two stakeholders (*M* = 2.33, *SD* = 1.85) in the technology roadmapping task and five *additional* stakeholders (*M* = 4.94, *SD* = 2.15) in the ethics-based task. The difference in considered stakeholders was significant according to the conducted ANOVA, $F(1, 51) = 50.05$, $p < 0.001$, $\eta^2 = 0.50$.

When the three ethical perspectives are considered separately, results show that the participants identified more new stakeholders in the utilitarian analysis (*M* = 3.31, *SD* = 1.79) than in the technology roadmap, followed by virtue ethics (*M* = 1.04, *SD* = 1.20) and deontology (*M* = 0.59, *SD* = 0.88). Also, participants analysing the telemedicine system mentioned notably more stakeholders overall (*M* = 4.31, *SD* = 1.37) than those analysing the smart teddy bear (*M* = 3.04, *SD* = 0.90; $p = 0.002$). I interpret this result in relation to the more balanced research design in the second study iteration, where the participants explicitly listed direct and indirect stakeholders *before* developing a technology roadmap. There was also a significant product/approach interaction effect with the bike courier app inspiring the participants to acknowledge more additional stakeholders in the ethics-based approach than the other IT products.

Because stakeholders needed to be explicitly listed prior to technology roadmapping for the telemedicine platform, I only used this case to look into the details of who was considered by the participants. Two primary users heavily dominated the stakeholders in both approaches: patients (mentioned 242 times in the ethics-based approach and 45 times in the technology roadmap) and doctors (mentioned 256 times in the ethics-based approach and 79 times in the technology roadmap). This commonality signals that both approaches are suited for identifying the most important direct stakeholders. However, many distinct stakeholder roles were recognized in the ethics-based approach that were not seen at all in roadmapping (see Table 10 for the detailed list); for instance, colleagues, community and family—but also employer or shareholders. Society and the public are crucial indirect stakeholders in the shared value literature (Porter & Kramer, 2011) but were not mentioned once in technology roadmapping, compared to 20 times in the ethics-based approach planning. More importantly, ideas from the ethics-based approach referred to a generic “user” only about half as often (24 times) as ideas from the technology roadmapping (46 times). Thus, the ethics-based approach produced ideas that considered a much wider range of stakeholders, including a perspective of the common person (“everyone”) as well as society at large.

4.2.8. Conclusion: Ethics Inspires Creative and Value-oriented IT Innovation

Results yield several insights into the creative thinking around values of individual participants. First, the ethics-based approach yielded an average of 18 value ideas, which is more than a threefold increase on the average five ideas from the traditional technology roadmapping. For the bike courier app, the ethics-based approach yielded as much as five times as many value ideas as the technology roadmap. Second, I considered the nature of the participants' ideas by looking at the different value classes (social, individual, technical, economic, environmental) that they cover. As expected, the participants focused on technical and economic values in the technology roadmap. When using the ethics-based approach, the participants showed a higher flexibility in thinking about values and covered four value classes, opening up innovation ideas that also included social and individual values. The third creativity aspect I investigated was the originality that the two approaches can spark off, operationalized as the infrequency of a value idea among the pool of ideas generated for each IT product. Here, too, the ethics-based approach inspired the participants to think outside the box and come up with value ideas that target context-specific stakeholders and interactions rather than the mainstream values that the technology roadmap approach elicited, as demonstrated by an originality score that was three times as high in the ethical analyses of the bike courier app compared to the technology roadmap.

I want to add three important observations beyond the scope of the creativity parameters. First, the ethics-based approach uncovered important and morally relevant values in information systems: almost all intrinsic values (91.89%) that the participants came up with were elicited in the ethics-based approach, e.g., dignity, freedom, or personal growth. Second, the ethics-based approach also acknowledged the technologies' impact on virtues such as courage, integrity and self-discipline, as well as on vices such as greed, jealousy, and loss of patience. And lastly, the ethics-based approach helped the participants to identify potential adverse effects for a broader set of direct and indirect stakeholders.

Overall, the three IT products under investigation show similar patterns across the different parameters that I investigated, supporting the applicability of an ethics-based and value-oriented approach for technologies with different physical setups, purposes, and contexts. Still, results differ in a few aspects, which I wish to discuss below. First, the significantly higher output of product ideas regarding the telemedicine system may have resulted from the participants' use of the online interface in the second study iteration. This interface allowed the participants to link several ideas on product characteristics to each idea that they had inserted in the three ethical analyses, which could have motivated them to come up with more ideas for product improvements. Second, the smaller sample of participants working on the bike courier app may have made it easier to come up with ideas that few others in the group also thought of, resulting in higher originality scores for this product. Lastly, the improved instructions in the second study iteration (the telemedicine system) provided a more balanced focus on stakeholders across the technology roadmapping and the ethics-based approach. The participants explicitly listed stakeholders prior to engaging in the technology roadmapping task. It might have been this change in study instructions which has led to the substantial increase in stakeholders acknowledged in the technology roadmap. This finding suggests that a prior listing and thereby explicit conception of a wider set of stakeholders may lead to an increased consideration of diverse stakeholders, irrespective of the innovation method used. Still, the participants acknowledged different stakeholders in the ethics-based approach than in their technology roadmap, including society and the community.

4.3 How Does Value-Based Thinking Influence IT Investment Decisions?

Based on empirical results in Section 4.1, I have argued that ethical theories can inspire individuals to identify values that are morally relevant for a specific technological product and affected stakeholders. Results presented in the subsequent Section 4.2 have shown that an ethically inspired value analysis can extend the technology roadmap of a product or service beyond technical and economic mainstream values.

In this chapter, I look into whether a value-based analysis from different ethical perspectives can also support the critical evaluation of a technological product or service and lead to an ethically informed decision on whether it should be developed and put on the market at all. In order to answer RQ3 "How Does Value-Based Thinking Influence IT Investment Decisions?", we asked the participants in both study iterations to indicate whether they would invest in the technological product or service that they had analysed and to provide an explanation for their decision. Figure 11 in Section 3.5.4 on investment decisions provides a detailed overview on decisions taken throughout the innovation tasks.

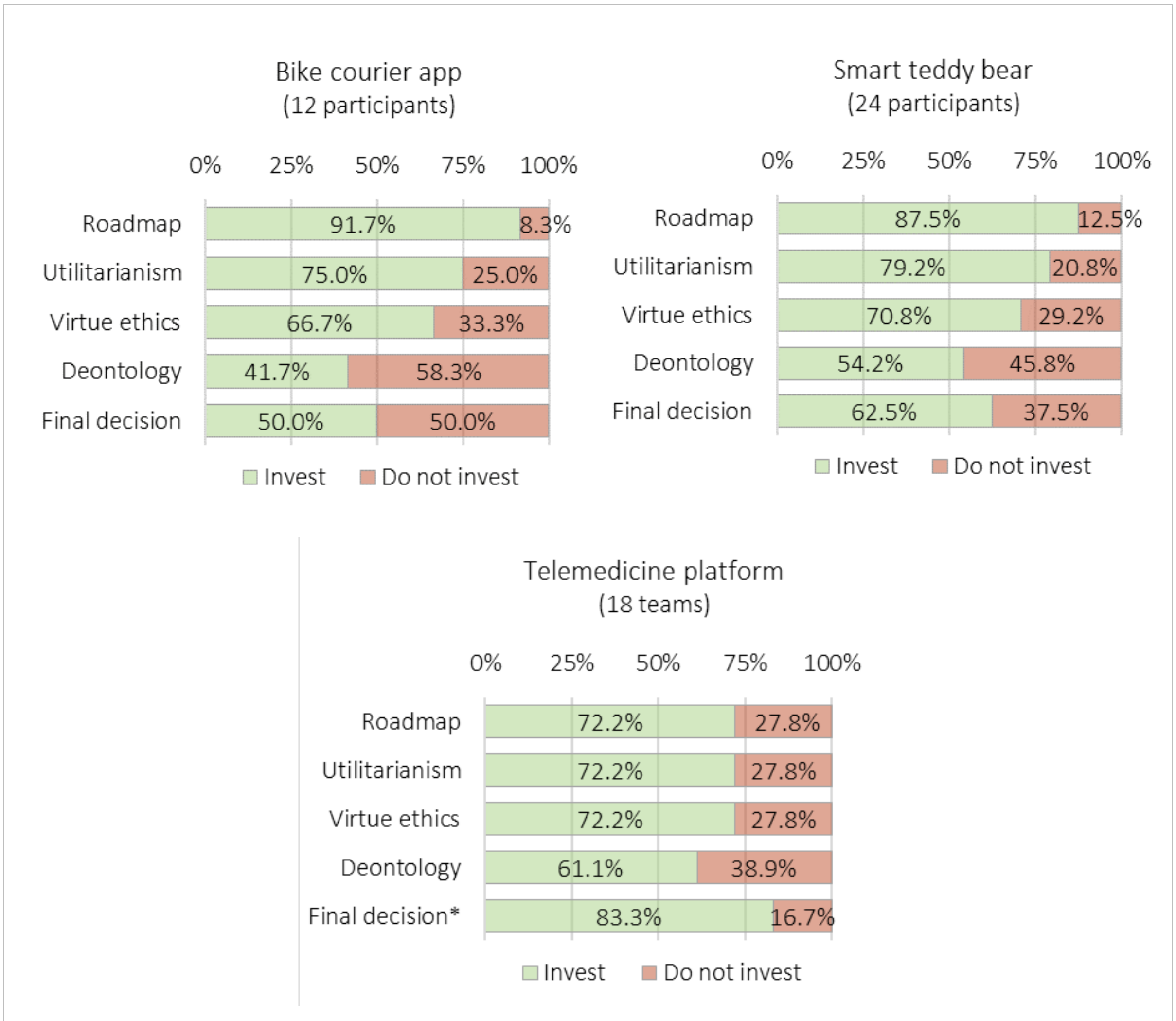
In the following, I present patterns of decisions for/against investment and discuss strategies that become apparent in the participants' explanations of their decisions to answer RQ3.1 ("Do ethical perspectives change investment decisions for a product/service that was initially described in a traditional technology roadmap?") in Section 4.3.1. I discuss how the number of identified value harms and benefits presented in Section 4.3.2 could have influenced the participants in their decisions for the bike courier app, the smart teddy bear, and the telemedicine platform. I answer the related RQ3.2 ("If yes, how do individuals decide?") and RQ3.3 ("Which patterns can be observed in investment decision-making?") in Section 4.3.3. As more detailed data was collected for the telemedicine platform, including investment decisions for the initial and the improved design of the IT product as well as a detailed reasoning behind each decision, I present this case study in more detail. What is especially noteworthy are the findings resulting from the qualitative analysis of reasons that the participants had provided for their decisions to invest, which I present in Section 4.3.4. Both the qualitative analysis of the telemedicine platform and an additional follow-up study on the bike courier app (described in Section 3.1.3) serve to answer RQ3.4 ("Finally, how do value-based improvements of an IT product/service affect initial decisions made against investing?") in Section 4.3.5. In Section 4.3.6, I conclude with a critical discussion of both a potential pro-investment bias that seems to be present especially in technology roadmapping and general learnings regarding a value-based evaluation of technology design, which I further elaborate below in my discussion of implications, see Section 5.1.5.

4.3.1. Decisions For/Against Investment

Across all three IT products, the participants showed a clear tendency to decide *pro* investment, see Figure 21. Still, the participants' decisions *not* to invest increased with each ethical analysis for the bike courier app and the smart teddy bear. Compared to the decisions after the technology roadmap, the ethical perspectives seem to have led to a change of mind towards a more critical view of these two products: in their final decision, only roughly 50% to 60% of the participants decided to invest, whereas around 90% had decided to invest after the technology roadmap. In contrast, the willingness to invest in the telemedicine platform was much more stable across the different analyses (61.1%–83.3%).

To find out which ethical analysis can best predict the final investment decision, I considered individual decisions of the participants that were identical with the final decision. In line with the results presented above, the predictability of the final investment decision increases from the initial decision after the technology roadmap (41.7% and 58.3%) to the deontological analysis (91.7%) for the participants working on the bike courier app or the smart teddy bear, see Table 11. For more than 90% of the participants, the decision after the deontological analysis was identical with their final decision. While it is difficult to say whether this was due to the order of analyses or the deontological reasoning based on the findings presented here, results of the follow-up study (see Section 4.3.5 below), which compared different groups of participants that had conducted only one ethical analysis, show similar patterns, with the deontological perspective resulting in the highest rejection rate of the analysed product. Thus, it is probable that it is indeed the deontological focus on moral obligations and principles that inspired a more critical evaluation of the respective technology.

Figure 21. Share of investment decisions regarding the initial design after the technology roadmap and each ethical analysis for all three IT products



Note. Final investment decisions for the telemedicine platform targeted the overall *improved* product design and thus are difficult to compare.

As discussed above, the variation of decisions of participants working on the telemedicine platform is generally much lower compared to the other two case studies. What is more, there is a slight decrease in the predictability of the final investment decision for the deontological perspective. A detailed discussion of the telemedicine platform follows further below in Section 4.3.4.

Table 11. Correct predictions of individual investment decisions for the three IT products

	Bike courier app (11* participants)				Smart teddy bear (24 participants)				Telemedicine platform (18 teams)			
	Total	*%*	*Yes*	*No*	*Total*	*%*	*Yes*	*No*	*Total*	*%*	*Yes*	*No*
Roadmap	5	45.5	5	0	14	58.3	13	1	16	88.9	13	3
Utilitarianism	9	81.8	6	3	20	83.3	15	5	16	88.9	15	3
Virtue ethics	9	81.8	6	4	22	91.7	15	7	16	88.9	15	3
Deontology	10	90.9	5	6	22	91.7	13	9	14	77.8	13	3

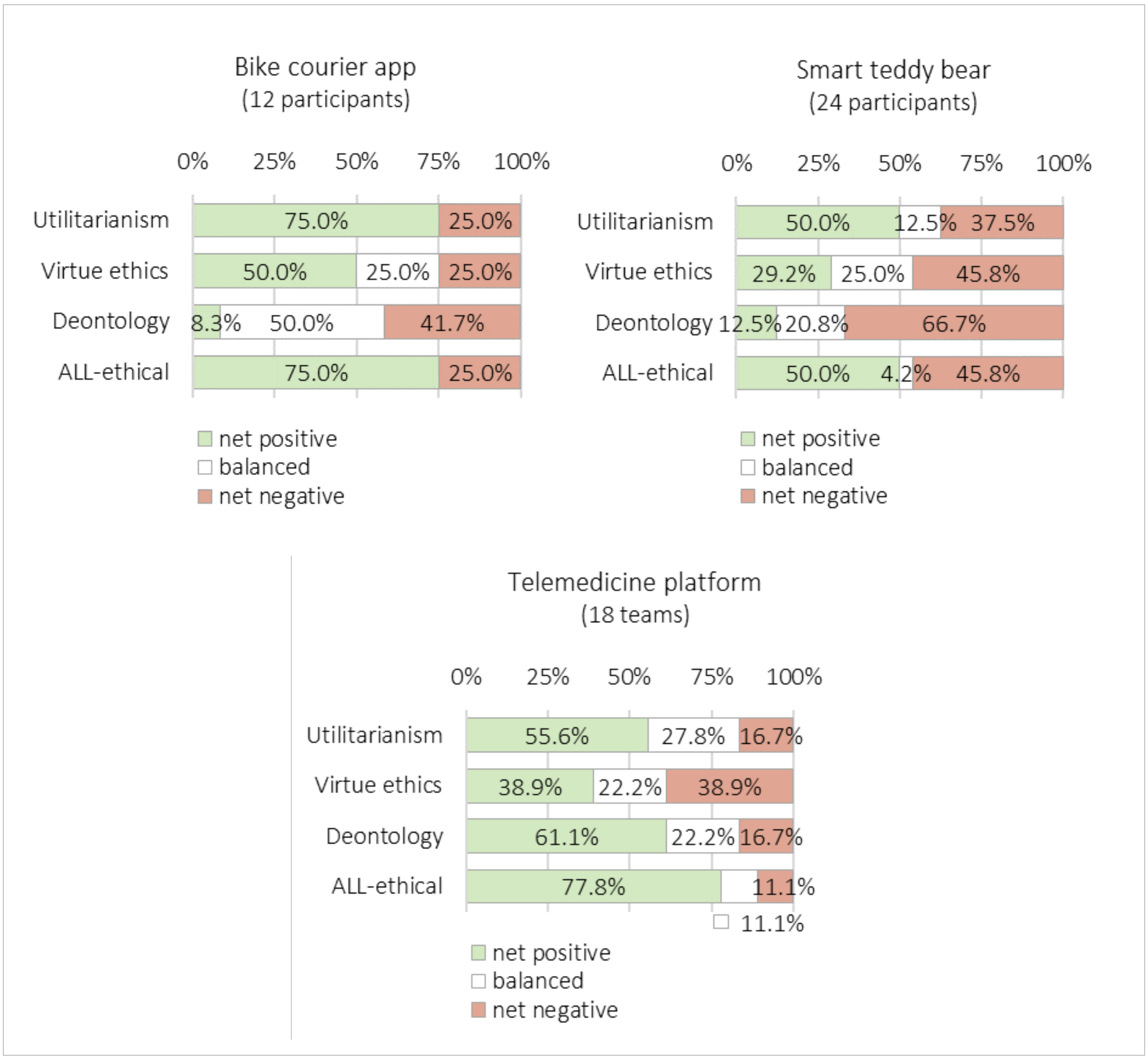
Note. A prediction is considered correct when the investment decision in the initial design after an ethical analysis is identical with the final investment decision. Next to the total number of correct predictions, numbers for correct Yes and No predictions are also shown. The final investment decision for the telemedicine platform targeted the overall improved product design and thus is difficult to compare. *One participant working on the bike courier app is excluded here for not indicating a final decision.

4.3.2. Anticipated Value Effects

As discussed in the introduction, potential value harms as well as benefits may guide a critical evaluation of an IT product including the decision to invest in its development and market launch. Looking at the pool of ideas that the participants noted down in all three ethical analyses for each IT product, beneficial and adverse effects are generally almost balanced: the percentage of ideas describing beneficial effects ranges from 47.8% (smart teddy bear) to 54.2% (telemedicine platform). However, this seemingly balanced result only applies to the aggregated ideas across the participants; it changes for the net value effects for each participant, i.e., whether they identified more positive than negative (*net positive*), more negative than positive (*net negative*) or an equal number of positive and negative value effects (*balanced*), see Figure 22. As the participants did not identify *any* negative effects in the technology roadmap task, the roadmap is not included in the following figures.

In the ethical analyses of both the bike courier app and the smart teddy bear, the share of participants with net *positive* value effects decreases from the first ethical analysis to the last, where the deontological analysis yields the biggest share of participants with net *negative* value effects. Interestingly, several participants achieve a *balanced* result, having identified as many positive value effects as negative ones. Again, the telemedicine platform shows a different pattern: here, the deontological analysis yields the highest share of participants with net *positive* value effects.

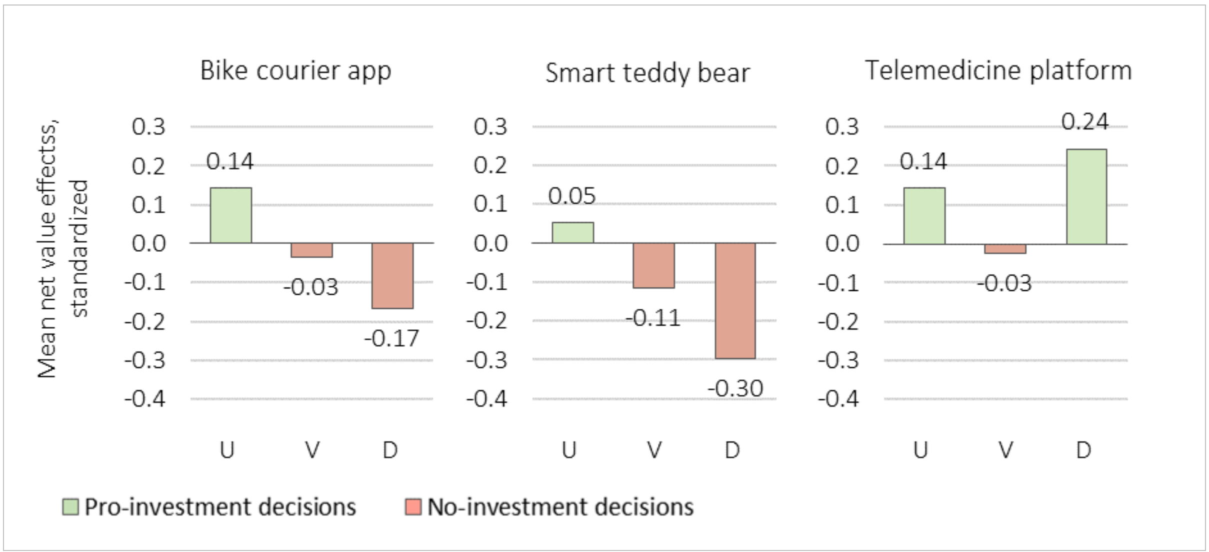
Figure 22. Net value effects across the three ethical analyses for all three IT products



Note. Numbers indicate the share of participants who identified net positive, balanced, and net negative value effects.

To better understand whether the different ethical perspectives inspire the participants to identify more positive or negative value effects, I computed the mean standardized net value effect, which represents the number of negative value effects subtracted from the positive ones and corrected by (i.e., divided by) the total number of value effects identified by a participant (see Section 3.5.3 for details and examples). Figure 23 shows that the participants identified more potential value harms than value benefits in the virtue ethics analyses of all three products and in the deontological analysis of both the bike courier app and the smart teddy bear. The utilitarian analysis always yielded net positive value effects, hinting at a more optimistic evaluation from the utilitarian perspective.

Figure 23. Standardized means of net value effects across ethical analyses for all three IT products



Note. Values are shown separately for utilitarianism (U), virtue ethics (V), and deontology (D).

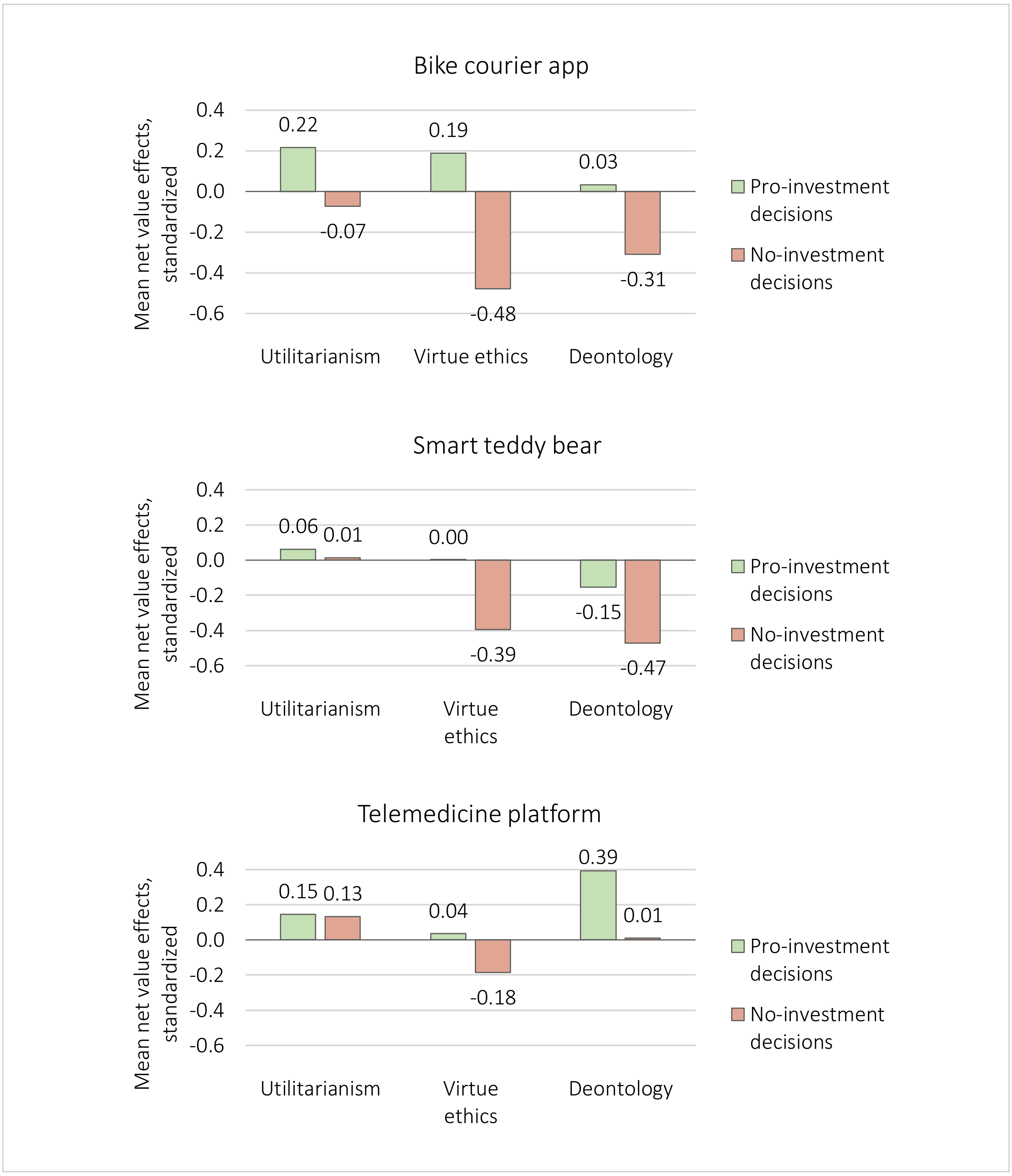
In the case of the telemedicine system, the number of identified value benefits compared to value harms is highest in the deontological analysis. Overall, the pattern of standardized net value effects coincides with the pattern presented above for the yes/no investment decisions. In the following, I investigate whether the net value effects differed in decisions for/against investment in order to identify a potential influence of identified value effects on investment decision-making.

4.3.3. Value Effects Driving Decisions For/Against Investment

Figure 24 shows the means of the standardized net value effects separately for the participants who decided pro investment and those who decided against investment. As can be seen in the figure, investment decisions seem to be correlated with a weighing of positive and negative value effects: the net value effects are always lower for the group of participants that decided against investment than the group that decided pro investment. This pattern can be observed for all three IT products.

Investment decisions thus seem to be driven by the (im-)balance of identified value benefits and harms rather than by the specific ethical perspective taken: the ethical perspective yielded different net value effects for different products and the investment decisions always correlated with the results. For example, the deontological analysis yielded net negative value effects for the smart teddy bear and the bike courier app and resulted in the biggest share of negative investment decisions, while it yielded overall positive value effects and overall positive investment decisions for the telemedicine platform. I present a more detailed analysis of individual decisions on the telemedicine platform in the following.

Figure 24. Standardized means of net value effects for group decisions pro/against investment across ethical analyses for all three IT products



Note. Standardized net value effects represent the number of negative value effects subtracted from the positive effects and corrected by the total number of value effects identified. These values are shown for utilitarianism (U), virtue ethics (V), and deontology (D).

4.3.4. Qualitative Reasoning Behind Investment Decisions in the Telemedicine Platform

The overall stable and predominantly positive decisions pro investment in the case of the telemedicine platform were surprising, as they differed from the other two products and did not reveal a clear impact of the utilitarian, virtue ethics and deontological perspectives. Another finding not in line with the bike courier app and the smart teddy bear was that teams working on the telemedicine platform did not always align each of their investment decisions with the effects on values and virtues that they had identified in their ethical analysis.

As discussed above, teams showed the tendency *not* to invest when the identified harmful effects outweighed the beneficial ones and to *invest* when benefits outnumbered harms. However, this does not explain all individual decisions. When looking at individual decisions, teams 3 and 7 opted for an investment although they had identified more harms than benefits in the preceding ethical analysis, while teams 5, 6, 13, and 14 decided against investing after having identified more benefits than harms. Teams 11 and 17 show both of these tendencies in several decisions, deciding against investment despite net positive effects and for an investment despite net negative effects identified in the respective ethical analysis. What is more, all teams had identified potential value harms for the telemedicine platform in *at least one* ethical analysis, and 16 out of the 18 teams had identified harms in *all three* ethical analyses. And still, the majority of teams opted to invest, see Table 12. One third of the teams even decided pro investment in every single investment decision that they had taken (Pattern 1: “Yes-sayers”). With this tendency towards investing, the participants showed an overall optimistic view of the telemedicine platform’s success.

Another important observation is that many teams did not show an increased willingness to invest after coming up with product improvements that would be considered in the ongoing product development. As can be seen in Table 12, only seven teams changed their initial negative decision to a positive decision after an ethical analysis (captured by Pattern 2 in the table). As it is not the individual ethical perspectives, nor the weighing of identified beneficial and adverse implications or resulting changes to the product’s design, the question arises what the teams’ decisions were based on. To better understand the reasoning behind their investment decisions, I looked into the teams’ explanations that they had provided for each of the eight investment decisions. In the following, I first analyse the reasons that participants deciding against investment based their decision on. Then, I turn to the three core arguments that teams deciding for an investment seem to have followed in their decision-making.

Table 12. Investment decision patterns and net value effects for all teams (*N*=18)

Pattern	Technology roadmap		Utilitarianism (U)			Virtue ethics (V)			Deontology (D)			Total (U, V, D)	
	Net value effects	Investment	Net value effects	Investment		Net value effects	Investment		Net value effects	Investment		Net value effects	Investment
Team ID		Initial		Initial	Improved		Initial	Improved		Initial	Improved		Improved
Pattern 1 ("Yes-sayers"): Persistently positive investment decisions													
Team 3	+26	Yes	+4	Yes	Yes	-3	Yes	Yes	-5	Yes	Yes	-4	Yes
Team 4	+4	Yes	0	Yes	Yes	+1	Yes	Yes	+2	Yes	Yes	+3	Yes
Team 7	+2	Yes	-3	Yes	Yes	0	Yes	Yes	0	Yes	Yes	-3	Yes
Team 8	+4	Yes	+1	Yes	Yes	0	Yes	Yes	+2	Yes	Yes	+3	Yes
Team 10	+5	Yes	0	Yes	Yes	+5	Yes	Yes	+6	Yes	Yes	+11	Yes
Team 19	+5	Yes	0	Yes	Yes	0	Yes	Yes	+1	Yes	Yes	+1	Yes
Pattern 2: Positive investment decisions except one negative decision regarding the initial product design													
Team 1	+4	Yes	0	Yes	Yes	-1	No	Yes	+1	Yes	Yes	0	Yes
Team 5	+15	Yes	+3	Yes	Yes	+1	Yes	Yes	+3	No	Yes	+7	Yes
Team 11	+12	Yes	+2	No	Yes	-1	Yes	Yes	+1	Yes	Yes	+2	Yes
Team 12	+4	Yes	+1	Yes	Yes	-5	No	Yes	+2	Yes	Yes	-2	Yes
Team 15	+7	No	0	Yes	Yes	0	Yes	Yes	+2	Yes	Yes	+2	Yes
Team 17	+2	Yes	+6	Yes	Yes	-4	Yes	Yes	+1	No	Yes	+3	Yes
Team 18	+21	Yes	0	Yes	Yes	+1	Yes	Yes	-3	No	Yes	-2	Yes
Pattern 3: Mixed investment decisions													
Team 9	+14	No	-1	No	Yes	+4	Yes	Yes	+3	Yes	Yes	+6	Yes
Team 14	+4	No	+1	No	Yes	+1	No	No	-1	No	No	+1	No
Team 16	+2	Yes	+1	Yes	No	+2	Yes	Yes	-2	No	No	+1	Yes
Pattern 4 ("No-sayers"): Persistently negative investment decisions													
Team 6	+7	No	+2	No	No	+2	No	No	+1	No	No	+5	No
Team 13	+5	No	+1	No	No	-1	No	No	+1	No	No	+1	No
Total													
Yes		13		13	15		13	15		11	14		15
No		5		5	3		5	3		7	4		3

Note. The last two columns show the sum of harms and benefits ("Net value effects") across all three ethical analyses and the final investment decision ("Investment/Improved") considering all product improvements suggested by the team.

After completing the technology roadmap, five innovation teams decided against investing in the product design that they had just analysed, mostly because of a high perceived risk regarding the digital health service market. The persistent No-sayers (teams 6 and 13) stuck with this initial decision *not* to invest. Team 6 explained this with the same reasoning across all analyses: the unique selling proposition of the telemedicine platform is not persuasive when compared to the trustworthy relationship with a general practitioner. Thus, few patients would be interested in using it, resulting in no prospect for long-term growth of the company. Team 13 also focused on classic economic factors throughout their decisions, pointing to a lacking monetization concept, legal and technical obstacles, and a difficult market. The team changed their reasoning only in the virtue ethics analysis, where they explained their decision against investment on account of the risk that patients might abuse the platform to get at medication and sick notes. Both teams 6 and 13 did not show differences in their argumentation for their investment decisions in the initial versus the improved design. This implies that their initial opinion of the telemedicine platform, resulting in a decision against investment, was strong enough not to be influenced by the ethical implications identified for the product, despite the various positive value effects that they had also mentioned.

Explanations for investment decisions of both the Yes-sayers and the teams with mixed decisions seem to have followed three main strategies, which I present in more detail below: 1) weighing the number of identified harms against the number of identified benefits (Strategy 1: Cost-benefit analysis), 2) considering the ethical implications based only on identified beneficial effects (Strategy 2: Positivity bias), 3) ignoring the results of the ethical analysis altogether and focusing on the positive future of the new technology (Strategy 3: Pro-technology innovation bias). Teams that conducted a classic cost-benefit analysis weighed the potential effects of the telemedicine platform, considering both value harms and benefits (strategy 1). However, strategies 2 and 3, which both represent a *biased* strategy to deal with harms and benefits, were used to a comparable extent. The use of these different strategies was not specific to a particular ethical theory, nor was there a cluster of teams that predominantly used one argumentation.

Interestingly, even when teams argued that the mere number of benefits outnumbered the harms, following strategy 1, this was not always in line with the actual number of harms and benefits that they had noted down. What is more, many teams did not seem to give negative effects enough weight in their investment decision, often resulting in the positivity-biased strategy 2. For example, despite having identified 11 harms and eight benefits, team 3 decided to invest in the virtue ethics analysis based on the value benefits, arguing that the "system should offer the user a service with special care to privacy and quality of the system". This does not explain why the potential negative value effects that they had identified, e.g., potential harms of patients' trust in both doctors and electronic health-care services, doctors' honesty, as well as their respect for each other, are *not* or *less* important. Following strategy 3, many teams expressed the conviction that the telemedicine platform had the power to revolutionize the health-care system and aligned their investment decision with this generically optimistic view of the IT service. For example, team 18 expressed a recommendation for investment because of the "big opportunity" they saw for the company in the first-mover advantage as one of the "precursors of a revolutionized medical system".

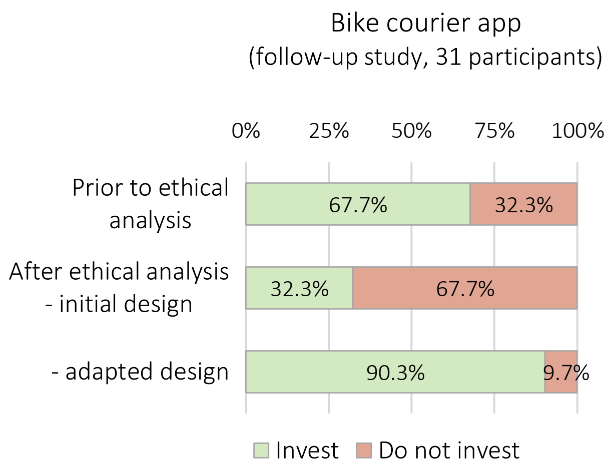
To summarize, many teams either ignored the results of the conducted ethical analyses altogether and focused on the market position and innovative power of the product, or took the ethical implications into account, but blocked out potential value harms in favour of benefits. In Section 5.1.5 "Biases in Early-stage Investment in New IT Products" below, I discuss these empirical findings critically and relate them to the literature.

4.3.5. Follow-up Study: Value Effects and Design Adaptations

The participants working on the telemedicine platform showed an overall optimistic view of the platform's commercial success. Overall, there were only few decisions against investment. Several participants had already made up their minds after the technology roadmap, ignoring ethical implications as well as product improvements that tried to mitigate potential adverse value effects. What is more, across the three ethical analyses, a change from a negative to a positive investment decision could only be observed in eight out of the total 54 decisions taken by the 18 teams (14.8%). To see whether these results are generalizable or specific to the telemedicine case study, I investigated data from the follow-up study on the fictitious bike courier app ($N = 31$ participants, see Section 3.1.3 for a description of the follow-up study).

Overall, the ethical analyses clearly impacted the participants' investment decisions in the follow-up study on the bike courier app. As shown in Figure 25, the majority of participants (67.7%, $n = 21$) decided in favour of investment after an initial investigation of the technology roadmap. Conducting the ethical analysis then changed the decisions of eleven out of the 31 participants (35.5%), resulting in one third (32.3%, $n = 10$) that would still invest after having identified potential value effects from an ethical perspective. When asked whether they would invest in the *adapted* design of the IT product, that is, a version that incorporated all changes suggested by the participants, most participants wanted to invest (87.5%, *n* = 27). 18 participants (58.1%) changed their decision after the ethical analysis from a decision against investment to investing when taking ideas for an adapted design into account, which is significantly higher than in the case of the telemedicine platform.

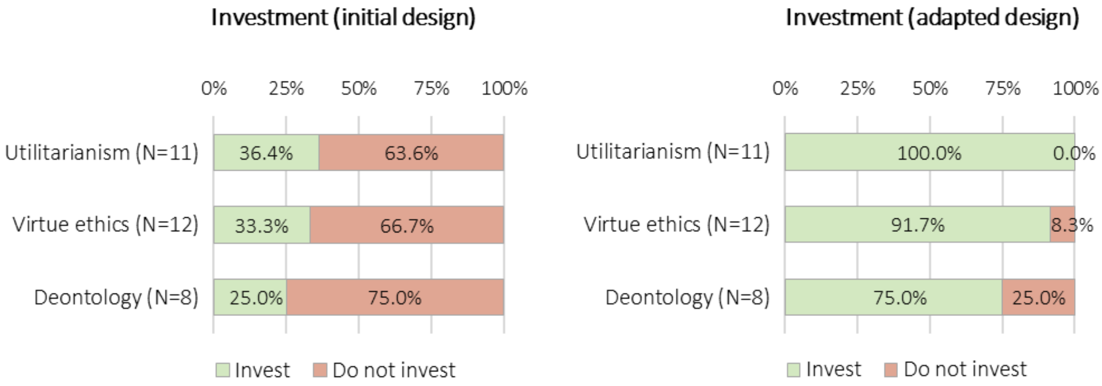
Figure 25. Development of investment decisions on the bike courier app prior to and after ethical analyses



Note. Investment decisions are aggregated for the 31 participants who were split into three groups applying a different ethical perspective each.

The participants showed a comparably low willingness to invest in the initial design of the product after a utilitarian and virtue ethics analysis (33.3%–36.4%). Still, deontology seems to provide the most critical ethical perspective as significantly fewer participants wanted to invest in the initial product design (25.0%). Comparing the decisions on the adapted design based on suggested product improvements, decisions of the group conducting a deontological analysis differed from the other groups even more. While 75.0% of the participants that had conducted a deontological analysis opted for an investment, *all* participants that had analysed the same product from a utilitarian perspective and 91.7% of the virtue ethics group decided pro investment for the adapted product version, see Figure 26. Empirical findings from the literature suggest that deontological thinking is associated with social-emotional responses while utilitarian reasoning is associated with abstract thinking and high-level cognitive control (Greene et al., 2004). A strengthened social-emotional response in the deontological analysis might be one possibility to explain the differences in investment decisions especially between the utilitarian and deontological perspective.

Figure 26. Investment decisions of the three ethical perspective groups for the initial design (left) and the adapted design (right) of the follow-up study on the bike courier app



These findings are in line with the results presented above for the bike courier app and the smart teddy bear. They provide further evidence that value-based improvements for an IT product's design have the potential to mitigate ethical risks and support investments in technological products and services that are designed from an ethical perspective. Only half of the teams working on the telemedicine platform had taken this into account in any of their decisions. Also, these results provide additional evidence for the unique influence of different ethical perspectives and the general impact that taking an ethical stance can have on IT innovation.

4.3.6. Weighing Value Costs and Benefits Versus Theory-specific Tendencies

Results from the bike courier app, the teddy bear and the telemedicine platform suggest that investment decisions are largely based on a weighing of value benefits and value harms, which is similar to a classic cost-benefit analysis. The mean standardized net value effects, which show whether identified value harms or value benefits identified by a participant or team are in balance or whether either harms or benefits predominate, are always higher for the participants opting for an investment than for those that decided against investment.

If investment decisions were solely based on a weighing of harms and benefits, one would expect that net value effects for the participants who decided to invest are always positive (i.e., participants identified more value benefits than harms) and vice versa: value effects for the participants who decided against investment are always negative (i.e., participants identified more value harms than benefits). For the bike courier app, this is indeed the case: analyses of participants pro investment yielded net positive value effects while decisions against investment came with net negative value effects. However, the direction of the mean net value effect is not always in line with the direction of the investment decision: The participants who decided *against* investment in the utilitarian analysis of the smart teddy bear and the telemedicine platform as well as the deontological analysis of the telemedicine platform had a very small but yet *positive* net value effect while those deciding *pro* investment in the deontological analysis of the smart teddy bear had a net *negative* effect. Thus, decisions for and against investment seem to be *influenced* by the identified positive and negative value effects, but cannot be fully explained by a simple weighing of effects. What is more, it is not clear whether the correlation of net value effects and investment decisions is to be interpreted by "the more value benefits, the higher the willingness to invest" or by "the more value harms, the lower the willingness to invest".

A closer analysis of the teams' explanations for their investment decisions in the telemedicine platform further shows that the number of identified benefits and harms cannot be the only considered factor: teams that reported to have weighed beneficial effects against potential harms had emphasized the benefits without providing an explanation for why they had chosen to accept the negative effects. In the literature, it has long been known that managers will sometimes decide to pursue investment in IT-related projects that are not always supported by a quantified cost vs. benefit analysis to ensure competitive advantage (Bacon, 1992). Fenn (1995) noticed that this behaviour usually occurs at the beginning of the Hype Cycle when companies make risky decisions to adopt technology, even though they can hardly make "informed judgements about its costs and benefits" (Linden and Fenn, 2003, p. 6). This can be explained by the common belief among managers that "it is more important to keep ahead of the competition than to catch up with it" (Bacon, 1992, p. 346).

In addition to these observations, several theory-specific tendencies could be observed. First, utilitarianism was the most optimistic ethical perspective, resulting in the highest share of net positive effects and decisions pro investment for all three IT products. Second, deontology was the most critical perspective in the first study iteration, resulting in the highest number of decisions against investment and net negative value effects for the bike courier app and the smart teddy bear. In the second study iteration, deontology had a different impact on the telemedicine platform where it yielded the most positive results in terms of value effects of all three ethical perspectives. Still, teams working on the telemedicine platform showed the lowest willingness to invest in the deontological analysis. The mini-study with three groups employing one ethical perspective each provides further evidence for the first pattern. Deontology again resulted in the most critical product evaluations of the bike courier app. Differences that became evident only for the telemedicine platform could be ascribed to an overall positive view with regard to the moral duties and principles that are fostered through this specific technology system, such as health, privacy, and equality.

Then again, a closer investigation of the reasoning provided by the participants shows that students' assessment of the telemedicine platform might not have been based only on the consideration of value effects and the specific ethical perspective taken. Next to a weighing of harms and benefits, I identified two lines of reasoning in the qualitative analysis of investment decisions. Both ignore potential negative value implications and thus imply a bias in the value-based evaluation of new IT products.

4.3.7. Conclusion: Critical but Biased Decisions

Results from three case studies and a small follow-up study seem to show that many individuals form their opinion on a product's success at an early point of the innovation process, e.g., on the basis of a technology roadmap. However, several participants changed their decision after conducting an ethical analysis, which included the product's impact on different stakeholders, the moral development of the stakeholders' characters, and the adherence to universal moral duties.

Overall, the value harms and value benefits, which the participants identified in their ethical analyses, correlated with positive and negative investment decisions: Those that decided to invest had identified relatively more positive value effects than those that decided against investment. This shows that the participants were influenced by the potential value impact that they discovered in the ethical analysis of the respective technological product. Regarding the individual decisions that did not follow this pattern, I discovered biased strategies to manage the tension between potential value benefits and value harms.

This biased view on a new technological product's success became especially apparent in the low number of decisions that changed when the participants took the *adapted* product design of the telemedicine platform into consideration. In their explanations for why they chose to invest in the telemedicine platform, the participants widely ignored the value harms and ethical considerations that they had reflected upon in their ethical analyses. While the available data cannot provide insights into the reasons for these decision patterns, the telemedicine platform case study suggests that the participants could have been biased by the engaging live presentation on the start-up's envisioned IT product/service given by their CEO.

Overall, the empirical findings show potentials for basing a critical analysis of a technology on different ethical perspectives but also that participants had difficulties to consider ethical issues in their investment decisions. When instructed to think of both positive and negative outcomes, individuals seem to focus too much on weighing pros and cons in terms of their number rather than trying to comprehend stakeholder implications of specific values and their moral impact. Also, the technology roadmap, live presentations of new IT products and services and the utilitarian perspective all seem to lead to an overall optimistic and potentially positively biased view of a technology's impact and success.

5 Discussion and Outlook

In the following, I want to discuss implications of the results presented in Chapter 4. First, I address "Implications for IT Innovation Practices and Value-oriented Design" in Section 5.1, where I emphasize the merits of a bottom-up elicitation of values from the respective technology context and the combination of different ethical perspectives, which all provide a unique angle on relevant values. I also discuss the importance of considering both beneficial and adverse value effects as well as a broad group of stakeholders in the design and development process of a technology product or service. Remarkably, the participants' reasoning in their investment decision-making also shows limitations of a value-based approach when it comes to influencing the evaluation of a new or redesigned technology product or service. This leads up to Section 5.2 "Limitations and Future Research", where I discuss both limitations of the presented empirical study in terms of study design, sample, and investigated variables as well as limitations of the investigated ethics-based value elicitation approach. My findings show that the participants struggled with the concept of values and virtues and the idea of ethical implications in general. I discuss these limitations and suggest directions for future research. In Section 5.3 "Outlook: Rethinking the Human-Technology Relation", I take a step back to re-evaluate the human-technology relation that investigations of technology design build upon. I discuss how difficult it is to draw a line between, e.g., the human and technology, or body and mind, and how new approaches call for a more flexible understanding of the human-technology (inter-) relation.

5.1 Implications for IT Innovation Practices and Value-oriented Design

Above, I have presented results on idea generation and idea evaluation in traditional technology roadmapping and an ethics-based approach in terms of captured value ideas and investment decisions. Results on value creativity consistently favoured a value approach rooted in ethical perspectives, showing significant differences with regard to all three value creativity parameters when compared with technology roadmapping. These findings have several implications for current practices in IT innovation and technology design.

Most importantly, they show that each ethical theory contributes a unique perspective on relevant values for a specific technology context that should be considered in subsequent steps of the design and development process. Together with selected insights on the concept of values in technology design, I discuss this as a key finding for value-oriented approaches as well as an important contribution to the development of VBE and the related IEEE 7000™ Standard (IEEE Computer Society, 2021; ISO, 2022; Spiekermann, 2023) in Section 5.1.1. I continue to discuss that both harms and benefits (Section 5.1.2) as well as contextual factors (Section 5.1.3) need to be considered in the technology design process. In Section 5.1.4, I consider how an ethics-based approach can add an ethically grounded value framework to traditional innovation practices, resulting in value-based technology roadmapping. And still, the participants recommendations to invest in the product or service they had analysed shows that a value-based technology analysis cannot compete with an overall optimistic evaluation of a technological product's success, hinting at the potential biases that I present in Section 5.1.5.

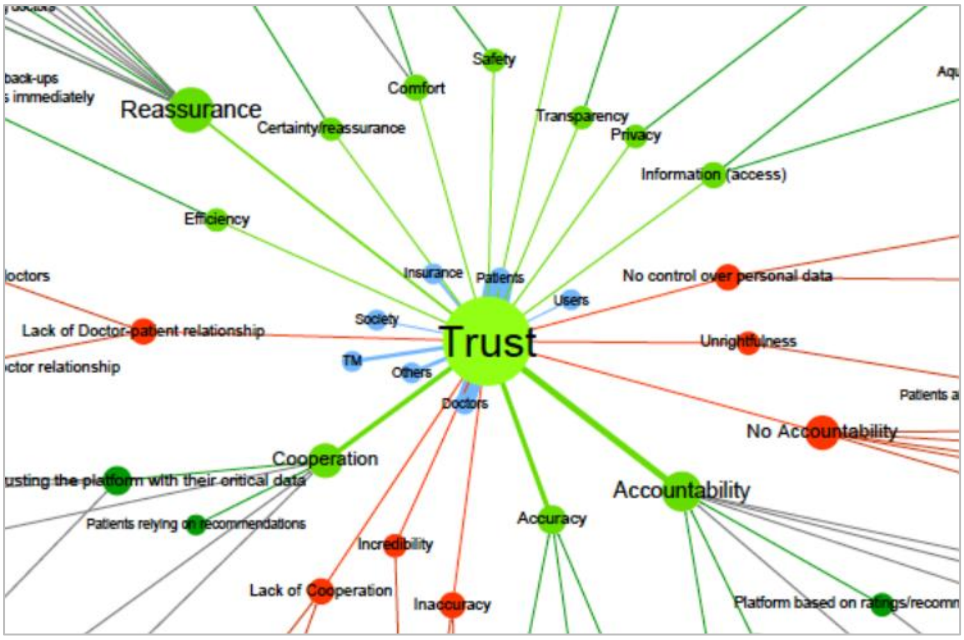
5.1.1. A Value-based Approach to System Design

The core finding of the presented empirical study is that thinking around values in technology design supports the consideration of ethical aspects. This result is key, as it shows that the lacking ethical foundation of VSD can be addressed by including ethical perspectives in the value elicitation process. What is more, the empirical findings provide an empirical legitimisation for the VBE approach (Spiekermann, 2023), which proposes a systematic framework for the design and development of information systems that incorporates an ethically grounded value concept. Both VBE (Spiekermann, 2023) and the related IEEE 7000™ Standard (IEEE Computer Society, 2021; ISO, 2022) have been informed by the findings of the empirical study that I present in this thesis. Of course, both frameworks go far beyond the presented study as they cover the whole technology design and development process in detailed steps and with accompanying standardised documents. Still, some of my empirical findings have significantly impacted the development process of these two approaches.

Two of the first empirical findings during the data analysis phase were that 1) values can be both supported or undermined and 2) values are not always positive, i.e., values do not only represent positive principles and ideas. While at first this insight seemed contrary to the common understanding of values in technology design, it is in line with Scheler's concept of values (see Table 1 above). When we looked into the nuanced value ideas that participants described, we realized that most of the intrinsic values that they mentioned were indeed positive (e.g., freedom, knowledge, or equality), while ideas related to virtues often enlisted vices (e.g., greed, obsession or laziness). In this thesis, I use the term "value effects" to capture both the positive and negative value implications that a technology's use can have. VBE (Spiekermann, 2023) acknowledges both the positive and negative value potentials related to a technology and further addresses how the value implications of a technology can be translated into specific requirements. Importantly, VBE (Spiekermann, 2023) also takes into account the challenges involved with identifying ways in which a technology can help to support the moral development of individuals in terms of virtues (discussed in Section 5.2.3 below). To avoid a misconception of virtues in technology design, VBE only asks to identify potential virtue *harms* or *vices* that could result from a system's implementation and to think about how such negative implications could be avoided.

Another important discovery concerns instrumental and intrinsic values. This differentiation has been made before, for example, when Spiekermann (2016) described how the instrumental value convenience can increase the intrinsic value happiness. However, only when we analysed the pool of ideas that all participants had provided, did we discover that many of the mentioned values relate to each other and thus form a network of values that is connected at different levels. Figure 27 shows a section of a such a "value cluster" for the value trust in the telemedicine case study, which is linked to values such as transparency, reassurance, or accountability (Spiekermann-Hoff et al., 2019).

Figure 27. Section of a value cluster as presented by Spiekermann-Hoff et al. (2019), p. 13



Spiekermann (2023) realized that the description of a value effect bears important information not only for the identification of a value but also for how a technology influences it, and, in turn, can be designed to support it. Inspired by this insight, she developed the three-layered value ontology of VBE (Spiekermann, 2023, p. 53), which includes the core value (layer 1), the perceived value qualities (layer 2) and the value dispositions in the technology (layer 3). In VBE, intrinsic values form the core values, which are further specified and influenced by their associated value qualities in positive or negative ways. For the telemedicine case study, Spiekermann-Hoff et al. (2019) discovered 13 core values including health, trust, equality, privacy, and knowledge. The specification into different layers helps to translate intrinsic values into the context-specific level of *ethical value requirements*, that is, “organizational, technical or social measures that should be taken in order to protect or foster a value quality” (Spiekermann, 2023, p. 111).

One of the most important empirical findings is that the combination of several ethical perspectives is a fruitful approach to an ethically aligned and creative innovation process. This insight forms an important empirically grounded argument for VBE (Spiekermann, 2023) and the related IEEE 7000™ Standard (IEEE Computer Society, 2021; ISO, 2022), which support a pluralist ethical foundation for the elicitation of values. It is also relevant for related methods and research areas. Specifically, I want to discuss the implications for the hitherto most recognized and established value-oriented approach, VSD, which emerged in the 1990s.

In their recent publication, VSD scholars Friedman and Hendry (2019) stress that any ethical theory can be used for the value elicitation phase in VSD projects. My results show that this VSD position has some merit, as all ethical theories have an embedded idea of what is important for morally judging a situation and can thus help to identify values that have some moral import for a technology context. Up to now, more than half of the VSD projects and studies considered in a recent review have included an analysis of harms and benefits (Winkler & Spiekermann, 2021), implying an underlying utilitarian reasoning. In the empirical results that I present above, utilitarianism is the best ethical perspective when it comes to value fluency. However, utilitarianism is not suited to anticipate how a technology affects the long-term character and behaviour of stakeholders. Will patients get impatient if they become used to reaching a doctor online any time? Will doctors become jealous of their professional peers if they are not ranked highly on the telemedicine platform? What will constant digital companionship from early childhood do to the courage of children once they are without their digital friend? A total of 44 out of the 47 virtues (93.6%) identified for the three technologies were uncovered by the virtue ethics analysis. Virtue ethics was also a main driver of the significantly higher originality achieved in the ethics-based approach. The third ethical perspective, deontology, only added a few additional value ideas. Still, deontology contributed unique values such as self-care or better world and was especially sensitive to adverse effects. From these findings I conclude that an ethical framework for values should consider a heterogeneous set of ethical theories to capture various aspects of a technology's ethical impact.

5.1.2. Avoiding Harms versus Creating Benefits

A core argument for the application of value-based thinking is the balanced understanding of a technology, which can lead to both beneficial consequences and desired effects and harms and adverse effects. It is a widely known fact that detecting usability issues early in the process reduces costs and increases the acceptance of a software. Yet, the relevance of detecting and anticipating an information technology's effects on general aspects of human well-being and thriving in a social context and within a healthy environment has not resulted in wider awareness and is rarely reflected upon in design practices.

In the past years, empirical studies have investigated the adverse effects caused by technological innovations with a high degree of diffusion (Gimpel & Schmied, 2019). Johnson (2015) has argued that technological developments are controlled by humans, and where this is not the case, this is due to past human decisions in favour of technological developments that are too complex for human control. Thus, we need to invest resources in anticipating a technology's impact early in the development process. Very recently, the question of an organization's responsibility in the design and development of technology has been taken up by Martin et al. (2019), who come to the conclusion that "managers and firms can (and should) create and implement technology in a way that remains attentive to the value creation for a firm and its stakeholders including employees, users, customers, and communities" (p. 310). My findings show that ethical theories complemented by explicit instructions to identify both beneficial and harmful effects foster a much more balanced view of a technology's potential impact.

What is more, avoiding the potential harm of a value is not equivalent to creating value benefits. Interestingly, I discovered that not all values bear the potential to create beneficial effects that go beyond the mere avoidance of them being harmed. Consider the example of the much-discussed information privacy (which we classified as an individual intrinsic value) or IT security (an instrumental technical value). Both can be protected against being undermined through technical tools or measures such as encryption and anonymization. While the potential consequences of these values being harmed (e.g., loss of private data, security breaches, etc.) have been much discussed, it is difficult to imagine what extra benefits the full support of these values could bring about, e.g., when we consider a fully supported IT security. In contrast, values such as friendship or community are clearly positive for individuals and social groups, but can still be harmed. Consider, for example, how, on the one hand, technologies such as instant messaging both bring people closer together as they share their experiences more immediately but, on the other hand, also harm relationships by reducing personal contact (Bednar & Spiekermann, 2018). Here, a clear value benefit is at stake that could be lost or turned into a negative impact on the social life of an individual or group. Thus, ambitious motivations for an ethically aligned technology that creates real values for its users can be satisfied neither by a mere elicitation of positive values, as pursued in ethical guidelines and advertised by mainstream values (e.g., accountability, explainability, and fairness included in the IBM "Everyday Ethics for AI" guide, 2018), nor by a mere identification and avoidance of potential value harms, as is often the result of a classical IT ethics analysis. Instead, a more holistic view on values and their impact ensures that certain values are protected to avoid value harms, whereas others are fostered to create value benefits.

5.1.3. Value Elicitation from Context Versus List-based Approaches

There is much more to discover beyond the values currently promoted by lists when an ethics-based value elicitation process is employed as it can help to identify a wide spectrum of relevant values. The results presented in Section 4.1 show that the utilitarian, virtue ethics, and deontological perspectives inspired the participants to identify values that took into account the specific context and the affected stakeholders of each technology. The three perspectives helped to elicit not only relevant intrinsic values, but also instrumental values and virtues, which are often not acknowledged in lists. The identified values were relevant for areas of sustainability beyond the technical or economic dimension, although they particularly neglected the environmental dimension. Thus, if one understands the relevance of values in technology design as context-bound and values as a pluralist concept representing various dimensions of moral relevance, adhering to a list cannot qualify as a truly value-oriented approach. There is no shortcut to fully understanding the value impact of a technology once it is in widespread use.

In Section 2.3.1 above, I have discussed the dangers inherent in the use of preconfigured value lists and introduced the meta-review of Jobin, Ienca, and Vayena (2019), who identified 11 shared value themes in 84 reviewed policy documents. Table 13 shows the value codes that were included in the value themes by Jobin et al. and compares them to value codes resulting from the present research project. A direct comparison shows that the context-bound capturing of values with ethical theories, as tested in this thesis, covers all 11 value themes for all three investigated technologies, with two exceptions (environmental sustainability was not mentioned in the telemedicine platform and transparency did not come up in the analysis of the smart teddy bear). This shows that important values captured in lists will also be identified in a bottom-up value elicitation process guided by ethical perspectives.

Table 13. Comparison of values found in the present study with value themes from Jobin et al. (2019)

Theme	Included values by Jobin et al. (2019)	Included values in present study
Transparency	Transparency, explainability, explicability, understandability, interpretability, communication, disclosure, showing	Transparency
Justice and fairness	Justice, fairness, consistency, inclusion, equality, equity, (non-) bias, (non-) discrimination, diversity, plurality, accessibility, reversibility, remedy, redress, challenge, access and distribution	Fairness; Accuracy; Equality; Legal compliance; Sense of justice; Impartiality; Accessibility; Corruptibility
Non-maleficence	Non-maleficence, security, safety, harm, protection, precaution, prevention, integrity (bodily or mental), non-subversion	IT security; Safety; Health; Mental, psychological health; Integrity
Responsibility	Responsibility, accountability, liability, acting with integrity	Responsibility & reliability; Reliability & robustness
Privacy	Privacy, personal or private information	Privacy
Beneficence	Benefits, beneficence, well-being, peace, social good, common good	Satisfaction/happiness; Monetary benefits; Better world; Development of society
Freedom and autonomy	Freedom, autonomy, consent, choice, self-determination, liberty, empowerment	Freedom; Autonomy; Control; Independence
Trust	Trust	Trust; Trust in technology
Sustainability	Sustainability, environment (nature), energy, resources (energy)	Environmental protection; Durability
Dignity	Dignity	Dignity
Solidarity	Solidarity, social security, cohesion	Solidarity; Social/legal security; Work capacities

What is more, the rich spectrum of values that the participants discovered for each technology goes far beyond the themes mentioned in lists, which becomes most apparent in the following three aspects. First, Jobin, Ienca, and Vayena (2019) reported that "it appears that issuers of guidelines are preoccupied with the moral obligation to prevent harm" (p. 396). Companies certainly need to anticipate potentially adverse effects that digital technologies and media can entail (Gimpel & Schmied, 2019). However, the results presented above (see, e.g., Table 8) show that the consideration of beneficial effects opens up a much vaster space for a positive design. Ethics is not only about preventing harm, but also about fostering what is good or true. In line with this, the participants in the study I present did not only identify potential dangers to the privacy and independence of a child playing with a smart teddy bear, but also thought of different ways that a child could learn from the toy as well as of the advantages of a user-friendly and aesthetic design. For the telemedicine platform, the participants saw a potential negative impact on the patients' truthfulness and the problematic establishment of a patient-doctor relationship based on trust, but also provided ideas on how to improve the efficiency of a doctor's consultation (e.g., through an optimized scheduling of appointments, a digital anamnesis, and an improved visualization of a patient's data) to further support an empathic relationship between doctors and their patients.

Second, a narrow focus on values promoted by contemporary lists of principles ignores a technology's impact on human virtues and vices. Above, I have discussed the reliability of bike couriers, the kindness of children playing with a smart teddy bear, patients' commitment to their personal healthcare and the bike courier's potential loss of a healthy ambition, which lists of ethical principles do not account for.

Third, my results provide many examples of value nuances that represent a specific moral issue in the respective technology's context. For example, trust was identified as an important value in all three cases, i.e., when doctors are confronted with patients who ask for illegitimate sickness notes, when parents fear that the smart teddy bear unnoticeably records moments of their family life and leaks the data, or when a food-delivery company tracks bike couriers. It is very unlikely that these value nuances would be recognized from a mere top-down value perspective.

Taken together, these findings support previous claims that an ethics-based approach to values in technology needs a moment of ethical reflection and should not be constrained by the use of value lists. What is more, they support arguments for a pluralist ethical foundation of values. However, the literature suggests that value lists can still serve a purpose. First, they can act as a heuristic, especially in industrial settings with limited capacities (Borning & Muller, 2012). Second, important values like the United Nations' Sustainable Development Goals can be used to complement the bottom-up value identification process (Umbrello & van de Poel, 2021). Third, it has been argued that there are "sacred" or "protected" values that should never be compromised because of another value's prioritization (van de Poel, 2009). Value lists can provide a checklist for such protected values, as in the case of the value themes collected by Jobin, Ienca, and Vayena (2019) for the AI context. In conclusion, values need to be elicited from the technology's context, but the detailed description and classification of the 187 value categories that emerged from the participants' ideas in this empirical study for three IT products with different use contexts (see Appendix D "Category System") can still be used as an inspirational source for future value-based projects and innovation practices.

5.1.4. Adding Value to Technology Roadmaps

The presented results are of high relevance for current IT innovation practices, especially for companies that employ technology roadmapping and focus on technological capability and direct customers as stakeholders. Recent criticism has emphasized that traditional roadmapping needs to change in order to be able to accommodate current requirements (Münch et al., 2018). My findings are in line with this criticism.

Understanding product evolution mainly as driven by competitive technological developments constrains creative innovation by linking it only to economic and technical values. Moreover, results from the three investigated IT products show the need for corporate innovation practices to explicitly call for the consideration of possible harms. Across the three IT products, the technology roadmap did not capture *any* potential adverse effects, whereas an average participant discovered 10 adverse value effects for the respective IT product under investigation in the ethics-based approach. This shows that technology roadmaps ignore the variety of potential adverse effects (Gimpel & Schmied, 2019) and thus support a naïve, or at the least, an optimistic view on how information systems play out in the long run. Lastly, findings show that there is a diverse set of stakeholders that should be considered. Although traditional roadmapping considers stakeholders in the planning process, many of the approaches limit stakeholders to direct customers (Albright & Kappel, 2003), company stakeholders (Cosner et al., 2007), or prominent stakeholders from industry, academia and the government (Jeffrey et al., 2013). In the ethics-based approach that we employed in the empirical study, the participants acknowledged an additional set of important stakeholders such as society and community.

Companies that manage their incremental technical product evolution internally are confronted with the question of what strategic role they should grant the technology roadmap. I argue that technology roadmaps should be complemented by an ethics-based value framework *before* managers decide what the development team should work on. Just as in the setup of the study presented here, technology roadmapping can help to sketch out an initial operational concept for a system of interest, which can then be reviewed and refined with the help of an ethics-based approach with a focus on values, resulting in a value-based technology roadmap. Even better, the two approaches could be applied in an iterative way to account for the dynamic environment of current technology innovation. This does not mean that all identified values must flow into the final product or even the technology roadmap, but rather that they should be considered at an early stage so that some values can guide subsequent steps of the innovation process. Results presented in Section 4.2 suggest that such a combined approach can be hugely beneficial for companies.

5.1.5. Biases in Early-stage Investment in New IT Products

It was argued previously that moral judgments and intuitions are biased when focusing on technologies and values (Caviola, Mannino, Savulescu, & Faulmüller, 2014; Umbrello, 2018). In the empirical results presented in Section 4.3, the students predominantly opted to invest in the technology in most of their decisions. In their investment decisions, several teams showed a biased evaluation of their own value-based analyses. Strategy 2 implied a cognitive positivity bias based on the "hypothesis that the reality would be positive" (Peeters, 1971, p. 461). Strategy 3 linked positive investment decisions to a pro-technology innovation bias, based on the conviction that the IT product will be successful and that new technological developments will bring solutions to current problems. This could be noticed in the participants' optimistic attitude from the very first analysis. In the literature, this behaviour has been described as part of the Hype Cycle (Fenn, 1995), in which individuals establish disillusioned expectations as to the inevitable success of innovation in early stages. This is also confirmed in my findings on the decisions concerning the initial product design from the roadmap, where almost 75% of the decisions were in favour of investing. The positive attitude towards the product was supported by its novelty and pioneering features. By favouring a new product this way, the participants showed a high risk acceptance and readiness to adopt a new technology, which are characteristic of both "innovators" and "early adopters" (Lusoli & Miltgen, 2009).

Various scholars and practitioners postulate that a set of values and tensions among these values can inspire better technology design and innovation (Friedman et al., 2017; Meijer &

De Jong, 2020; Miller et al., 2007; Taebi et al., 2014). Based on this claim, I had expected that many teams would decide *not* to invest when they considered the initial design of the IT product/service in the technology roadmap and change their decision after product improvements had been taken into account. However, only around 15% of investment decisions with regard to the telemedicine platform followed this pattern. The participants had already expressed a high readiness to invest in the telemedicine platform before knowing about the possibility to adjust the product design based on the values identified in the ethical analyses. Since the participants had had no prior interaction with the telemedicine platform, they seem to have searched for "good reasons" to invest (Li, Hess, & Valacich, 2008). Yet, the mini-study that was conducted as a follow-up investigation supports my initial expectation that value-based improvements increase the willingness to invest, presenting contrary results to the telemedicine platform.

The teams' overall willingness to invest in the telemedicine platform could be traced back to the great influence of the initial technology roadmap that was presented by the CEO live in the classroom. This could have reinforced the perception that the telemedicine platform is an innovative product about to be developed and launched. The participants might have focused too much on the new forms of communication and information access that the telemedicine platform promoted, leading to the observed decision pattern pro investment. This hypothesis is further supported by the participants' expressed conviction that technological innovation would show increased value in the future, without providing more detailed reasons justified by current developments or past advancements. In the literature, this was described as the "gut feeling" phenomenon (Schniederjans, Hamaker, & Schniederjans, 2010), which can partly be explained by the difficulty to estimate the actual value of IT. In combination with a strong belief in the success of new technology despite the many harmful effects that the participants had identified, this phenomenon can be recognised as a *pro-technology innovation bias*.

This bias is unexpected, as an ethically framed value analysis for a specific technology should ideally reduce the effects of biases and support more rational and realistic evaluations. Especially in the deontological and virtue-ethical analysis, teams associated the telemedicine platform's success with the values it would bring about, such as "promoting healthy regimes and raising awareness" and "providing care for people who would otherwise not receive it". However, the beneficial effects that the teams identified for the product in the three analyses were rather balanced with identified harmful effects. This shows that overall, the participants often focused selectively on positive effects on values and virtues, ignoring potential harms and negative effects that could have inspired them to come up with new design options that would "better meet the relevant values" (van de Poel, 2015, p. 114).

Of course, high-level managers have a different perspective on IT investment than a group of students deciding on the investment in an imagined telemedicine platform. Still, what is observed here at a micro level could manifest itself as a pattern at higher levels. Thus, the tendency of the participants to believe that an IT product would be successful despite the risks that it posed might well apply to people working in product management positions or even to broader parts of the general population. This motivates further research on ethical frameworks for a value-based evaluation of IT products and the potential of value-based product improvements.

5.2 Limitations and Future Research

In the following sections, I discuss the limitations of the study design such as the within-subject design and the student sample (Section 5.2.1) as well as the question how the ethics-based value approach that I investigated could be extended or adapted (Section 5.2.2). I also address more general challenges related to the concept of values and virtues and the consideration of ethical implications that became apparent in the empirical study (Section 5.2.3). Lastly, I critically examine how I evaluated the ideas that the participants came up with in the respective tasks (Section 5.2.4).

5.2.1. Study Design

The underlying data that I have analysed to answer the three main research questions of this thesis are provided by an information systems student sample that analysed a technological product or service by developing a technology roadmap and taking a utilitarian, deontological, and virtue ethics perspective to identify relevant values. I have investigated the influence that each ethical perspective has on the resulting value ideas for three different IT products and services to assess the influence of both the particular theory and the technology context. I conducted elaborate qualitative data analyses and worked together with supporting researchers including both students and my PhD thesis supervisor to ensure the highest possible quality for the resulting findings. Still, the underlying study design comes with certain limitations, four of which I want to discuss in the following.

First, the participants were information systems students who engaged in the innovation tasks as part of a course on innovation management. It is not clear what the reported results would look like for senior IT professionals or other samples (e.g., ethicists, IT philosophers, engineers). Participating students had a solid technical and economic background with over 2,000 hours of attended lectures in management and IT. Also, many of them worked in companies. And still, they lacked the practitioners' experience and expertise of a dedicated design or innovation team in an IT company. Thus, a student sample has its potential weakness. In corporate practice, subject matter experts with insight into customer needs and the respective industry heavily influence product innovation management. Hopefully, the results I present here motivate corporations to engage in ethics-based value-oriented IT innovation projects and cooperate with research institutions. Insights from experienced managers and their teams across industries would add an important angle on this process to complement my results. What is more, van de Kaa et al. (2020) argued that different stakeholders could rank values differently, resulting in a different evaluation of values. While the sample of the presented empirical study consisted of international students from various countries, digital cultures and markets differ between countries (Lusoli & Miltgen, 2009). Thus, samples with a different mix of countries of origin could produce different results. Future research could take these and other factors such as social group, profession and expertise, age, and gender into account. Such research is especially interesting as the results that I have presented show a bias towards individual values across all three ethical analyses. Future research could examine whether the same value elicitation task generates different results when conducted with samples from a collectivist culture, or using another philosophical perspective.

Second, the participants were instructed to think of the entirety of directly and indirectly affected stakeholders. While this emphasizes the importance of diverse groups of people that are affected by an IT product or service, it is still limited in that the participants were asked to consider these perspectives instead of directly including representatives of these stakeholders. At the same time, it also allowed comparing how the consideration of stakeholders was influenced by the respective approach, making it possible to investigate, e.g., whether utilitarianism supported a person in thinking of more potentially affected stakeholders than virtue ethics.

Third, a potential third limitation is the within-subject design, which can cause carry-over effects for the participants analysing each technology several times in different tasks and from different (ethical) perspectives. I want to stress that such effects were mitigated by placing several weeks between the technology roadmap task and the ethical analyses and—more importantly—strictly controlling for all idea overlaps, that is, repeating ideas from each participant. Also, my main research aim goes beyond a mere *comparison* of methods. As argued in Section 5.1.4 above, technology roadmapping will continue to be an important part of IT innovation. My results show that traditional innovation practices can be enriched by *additional* practices with a value focus and that such a complementary approach to IT innovation can inspire creative and more ethically aligned ideas. Still, I want to emphasize that all statistical effects from the conducted ANOVAs need to be interpreted with caution because of the lacking randomization of the investigated approaches in the study design.

Lastly, there are both benefits and disadvantages in the team setup and the use of an online interface to note down decisions and ideas as used in the second study iteration. The participants worked in teams so that they could exchange ideas and reach a more objective evaluation. Still, it is difficult to estimate how the internal alignment of evaluations affected the decisions and reasoning of each team. Also, the online interface should present a less restricted form for noting down ideas, providing a clear and uniform structure for the ethical analyses while at the same time allowing for some flexibility with regard to the number of ideas. However, the specific structure it provided to keep the participants focused on the subject could have affected how they conducted the task and limited their output (Mills et al., 2005) or affected it in other ways. Here, it would be interesting to see more research on how the mode of noting down ideas leads to different results in a value-based design process.

5.2.2. Restrictions of the Investigated Ethics-based Value Approach

I want to note several limitations of the ethics-based value approach that I investigate in this thesis. A main critical aspect is the choice of principles and criteria for 1) the elicitation of values from an ethical perspective and the 2) evaluation of values (with an ethical perspective in mind). In this thesis, I chose utilitarianism, virtue ethics and deontology as ethical theories for a pluralist ethical basis for values and sustainability dimensions as well as the differentiation between intrinsic and instrumental values as criteria for the evaluation of resulting values. This can be criticized in several respects.

First, I compare three traditional Western ethical theories utilitarianism, deontology, and virtue ethics. These theories are often considered the big three theories of ethics (Stahl et al., 2014). They have been discussed in VSD (Friedman and Kahn Jr. 2003) and form the ethical basis of value-based design and VBE (Spiekermann, 2016, 2023). Yet, any selection of theories leaves out other theories that come with different perspectives and possibly a different cultural context, for example, more collective-oriented Asian philosophies. What is more, the ethical theories were operationalized by formulating questions that summarize the textbook understanding of the respective ethical theory and thus represent a simplistic version. Of course, the specific forms (e.g., utilitarianism) and descriptions (e.g., Kant's categorical imperative) that were presented to the participants in the empirical study cannot account for all existing variations of the three approaches. I am fully aware that there might be other ways to apply utilitarianism, deontology, and virtue ethics, or even better ones compared to the present empirical study. Still, I want to emphasize that exploring the influence of Western theories on decision-making that is typical for the Western world of business is an important contribution to a better understanding of attitudes towards technology and ethics. As discussed in more detail below, I understand my research as a first step and leave it to future research(ers) to investigate other ethical perspectives. My conclusion in this thesis is that each ethical principle represents a unique form of translating what is good and right into more concrete instances, be it values or actions. However, subsequent research could add to this by investigating the relevance of ethical principles for values in technology design with regard to both the breadth of ethical approaches and the depth of their implications.

To complement the results that I present above, it would be interesting to see future empirical research that investigates variations of consequentialist and deontological theories or virtue ethics and compares them to alternative philosophical and cultural approaches to ethics, such as Confucianism, Buddhism, etc. Where scholars explicitly discussed how to combine moral thinking with technology design, the choice of moral theory often consciously fell on theories and approaches that differ from traditional moral law theories such as consequentialism and deontology (Reijers & Gordijn, 2019; Umbrello, 2020b). Future research could investigate how these alternative approaches play out in the technology design process and to what extent the output in form of value ideas differs when compared to traditional philosophical theories. An alternative example could be the non-formal ethics of values of Max Scheler (1913-1916/1973). Scheler emphasizes that values are grasped intuitively in emotional acts of "value-ception" (p. 201), which could offer a different starting point for an ethically driven elicitation of values. Such an alternative framing for value elicitation would also add to the discourse on rationalist versus intuitionist models of moral reasoning in psychology (see, e.g., Haidt, 2001). Future research that looks into the different aspects that ethical theories address would contribute to the wider discussion of the use of ethical theories for technology design (Jacobs & Huldtgren, 2021).

Second, I especially think that our operationalization of virtue ethics, which is focused on the creative elicitation of stakeholders' virtues that could be fostered or harmed through the use of the respective IT product or service, departs from the common focus of virtue ethics on the person as agent, e.g., the designer or developer. The focus on the stakeholders' personal development and morally desirable behaviour and character traits and the role that technology plays in this regard is an interesting complement to classic utilitarian and deontological thinking and presents a relevant research aspect of its own. However, virtuous practice design (Reijers & Gordijn, 2019) relates the heuristic of virtues not only to the design of a technology, but also to aspects such as training, education, and regulation. These measures go beyond the technology design focus of this thesis and take the wider organisational context into account. With the design of the present empirical study, I could not assess how the virtues of those involved in decision-making processes for a technological product influence the design of the respective product and whether a virtuous person is likely to design a better IT product. Future research along these lines could add to existing literature on the motivation of software engineers to engage with moral behaviour in their professional context (Bednar et al., 2019; Roeser, 2012; Spiekermann, Korunovska, & Langheinrich, 2018).

Third, I want to note that not all values identified in the value elicitation phase at the beginning of the design process of an ethically oriented information technology system can be considered in all subsequent steps. Weighing values is a complex matter and several methods have been suggested for prioritizing values such as Value Dams and Flows (Miller et al. 2007), or, more recently, a Best Worth Method (van de Kaa et al., 2020). Even more importantly, it has been suggested that a set of relevant negative values can warrant the decision *against* designing a technology at all instead of weighing harms against benefits (Miller 2021). While I do not advocate any specific method for the final selection of values, it is important to emphasize that one should start from a set of relevant and context-specific values to be considered later in the design process. In this thesis, I aim to present first findings and motivations for including various ethical perspectives in the identification of such values.

Fourth, the participants were asked to identify values themselves by relating them to the technology effects that they discovered from the three ethical perspectives. While the empirical results show that directly addressing specific aspects is very successful, e.g., when it comes to considering both beneficial and harmful effects or asking about the stakeholders affected, it is questionable whether individuals need to identify related values themselves when engaging in ethical reflections. Friedman et al. (2006) have emphasized that stakeholders should be asked indirectly about values. This can be ascribed to their understanding of values as concepts that they “hold” but cannot directly reflect. And still, it is essential to reflect on benefits and problems of instructions that require to explicitly address a concept or an issue versus “at a minimum employing issues or tasks that engage people’s reasoning about the topic under investigation” (Friedman et al., 2006, p. 367).

Lastly, while results show that an ethics-based approach uncovers a broad range of relevant values, there is also an aspect where it fell short: the participants missed out on the impact that the three technologies could have on the environment. Only one environmental value was detected by the utilitarian analysis in the bike courier app, where a greener city was envisioned when bikes instead of cars were used to deliver food. This is a meagre result in times of abounding environmental discussions. The participants could have thought about the digital waste that is created when analogue products are digitalized as in the case of the smart teddy bear, or the CO_2 emissions caused by the many AI functionalities they planned to implement. Whether nature was not considered because of the specific instructions or the choice of ethical theories is not clear. Future research could investigate whether a different framing would mitigate the observed effects. For example, instructions could mention both human stakeholders and the environment when asking to “identify benefits and harms associated with the widespread use of the product/service [plus affected direct or indirect stakeholders and the environment]” in the utilitarian analysis. As an alternative, the principle of sustainability and its different dimensions could be used for *eliciting* values, for example, by asking “what values are important for the long-term interaction and coexistence of people”. In turn, the principles utility, duty or golden mean could be used for evaluating the resulting values or prioritizing them, for example, by asking, “which value relates to the highest degree of social utility/pleasure/well-being?”. Another possibility would be to list the environment as a fixed stakeholder throughout the technology design process, encouraging those involved to think about potential environmental implications.

5.2.3. Difficulties of Considering Ethical Implications

The three ethical analyses clearly inspired the participants to identify various values and virtues that the respective technology could foster or harm. However, I also want to discuss the difficulties that the participants seemed to have when taking an ethical stance.

In general, the participants clearly struggled with understanding the ethical foundation of the concept of values and virtues. This is mirrored in the category groups that my supervisor and I created to capture the different labels of participants' ideas. Many ideas that participants wrote down as values/virtues actually captured either product characteristics, personal characteristics/abilities, or emotions. As discussed in Section 3.4.3 "Values, Virtues and Other Category Groups", some participants simply listed an emotional state or characteristic of an individual when trying to identify relevant virtues. This explains the relatively high proportion of ideas classified as emotions or personal characteristics/abilities in the pool of virtue ethics ideas. We observed similar confusions with beneficial or negative effects on stakeholders that rather described an emotion than a value. We categorized ideas that did not represent any more general beneficial effect or principle as product characteristics. While we had initially intended to assort the participants' ideas in groups of instrumental values, intrinsic values, and virtues, the participants' vague notion of both values and virtues resulted in the categorisation of 26.6% of the ideas as either product characteristics, personal characteristics/abilities, or emotions.

What is more, even when the participants had a value or virtue in mind, they often misjudged the ethical implications that they described. On the one hand, they identified noteworthy issues with ethical import, but fell short in answering the underlying challenge adequately. For example, a participant realized that the smart teddy bear might negatively impact the child-parent relationship and suggested that the smart teddy bear should interview the child about the parents and if the answers were "too short" the bear should ask the parents to spend more time with the child. This solution completely disregards the complexity of human relationships *and* overestimates the capability of such a digital toy. On the other hand, the participants employed an overly optimistic view on the value benefits that they thought could be created. Many ideas describing a potentially beneficial effect of the technology on the character and good behaviour of the affected stakeholders seemed far-fetched and sometimes naïve. For example, the participants saw a beneficial effect of the bike courier app on the bikers' truthfulness because the tracking of the delivery process was considered to make it more difficult for bikers to give wrong information. In other examples, the ability to support a child's sense for justice was attributed to the smart teddy bear if the inbuilt artificial intelligence "is good enough" and the telemedicine app was described as supporting courage as patients scared of going to hospital could schedule a direct appointment with the medical practitioner. These ideas equip technology with an unrealistic power to influencing people's long-learned patterns and routines. They also ignore that the development of actual virtues requires high commitment of the person instead of a "technological shortcut" towards good behaviour, which led

Spiekermann (2023) to focus only on virtue harms or vices for specifying value-based requirements in VBE.

In the empirical study that I present in this thesis, the problematic examples above were complemented by important ideas on how to protect and further foster the child's autonomy, privacy and safety by reducing functionalities and limiting access. However, my observations underline that a serious and intensive examination and a critical analysis of both human and technological capacities is required to understand how a person's flourishing can be supported by technology. It also shows that merely applying ethical perspectives does not safeguard a critical understanding of technological features and how they might play out. Pommeranz and colleagues (2012) have argued that any value elicitation process needs to be accompanied by the right tools that support proper reflection and communication processes. Discussions between stakeholders and designers on how concrete values can best be addressed in a technology's design, as promoted by Pommeranz and colleagues (2012), could provide an additional measure to ensure not only that values are identified from a specific context, but also that adequate design requirements are derived from the identified values.

5.2.4. Evaluating Ideas for Technology Design

In my evaluation of value ideas resulting from different IT innovation approaches, I focused on Guilford's understanding of creativity in terms of divergent thinking and the three creativity parameters novelty, originality/rarity, and flexibility. With this approach, I followed previous empirical research on creativity, which used multiple indicators to assess the creativity of a person or product (Batey, 2012). However, any measurement of creativity is a challenge and I am aware of its limitations. For example, the number of ideas in terms of fluency does not say anything about their feasibility and sometimes one idea can be enough to guide the design of a completely new technology system or product. Still, I consider the creativity indicators that I developed for the presented study a noteworthy achievement for the quantitative operationalization of creativity in IT innovation. I am aware that various definitions of creativity and ways to measure it have been proposed in the literature and that my operationalization only takes up some aspects, leaving out, e.g., whether ideas are "useful", "efficient", "implementable", or "ingenious" (Dean et al., 2006). However, in this thesis I focus on the intersection of innovation, design and creativity in terms of *divergence* (Norman, 2013), that is, ideas generated early in the process, and do not cover subsequent steps of *convergence* such as the translation of values into specific functional requirements and technical specifications (van de Poel, 2009).

Second, my supervisor and I had difficulties when coding the participants' ideas on a higher level of abstraction. In the case of several ideas, the categorization into extrinsic/instrumental versus intrinsic values was difficult, which could be due to the context-dependency of values that has received wide academic attention (e.g., for the value privacy, see Nissenbaum, 2009). For example, we struggled with how to categorize business values such as productivity/profit, which represent the primary goal for neoclassical economics (thus indicating its qualification as an intrinsic value) but is not of relevance, e.g., for the child playing with the smart teddy bear. Moreover, it can even stand in opposition to higher values for primary users, e.g., because it supports unrightful processing of their private data. In order to acknowledge their relevance for stakeholders such as investors, we categorized such business values as instrumental values, leaving room for how they may play out when implemented for a concrete context. Environmental protection was another difficult case, as the meaningfulness of its value again depended on the subject. When nature is acknowledged as an independent factor for which a value bears relevance, it should be considered an intrinsic value. However, related to human agents and their needs, it might only be classified as instrumental, reducing its relevance to its contribution to a healthy life. In the end, we decided to categorize environmental protection as an intrinsic value as "environmental sustainability" forms one out of the five sustainability dimensions (Penzenstadler & Femmer, 2013) that generally acted as a guidance for classifying the empirically identified values.

Lastly, I need to stress a more fundamental point that has been made in the literature on a technology's impact and acceptance. Generally, it is difficult to define what acceptance with regard to a technology should capture. Factual acceptance, that is, the acceptance of a specific technology by stakeholders at a certain time, is not identical with ethical acceptance. Moreover, a technology being factually accepted cannot guarantee that it will not become problematic or rejected some years later (Grunwald, 2015). At the same time, a mere aggregation of individual values does not automatically signify ethical or technological acceptance (van de Kaa et al., 2020). This issue becomes more relevant considering that an estimation of a technology's potential impact early in the design process, when its characteristics can still be adjusted, is difficult due to little information being available (Grunwald, 2020). The approach I tested could be seen as "an empirically informed form of anticipation" (Kudina & Verbeek, 2019, p. 309), which tries to move away from merely speculating while still trying to take social and moral implications into account. And still, the approach does not fully account for the fact that a technology can bring about a change in the perception of values in society. These "soft impacts" (Kudina & Verbeek, 2019, p. 295) might influence to what extent the technology is accepted and how it is used. These are aspects which should ideally be considered in the technology's design. This shows that we need more studies on the benefits of an early value-based evaluation of a technological product and on how to deal with potential pitfalls.

5.3 Outlook: Rethinking the Human-Technology Relation

In this thesis, I have investigated what different ethical perspectives can contribute to the identification of human and social values that are relevant for a technology's context. Throughout my findings, values have proved to be a useful concept for capturing ideas and principles of what is good and right. What is more, my findings suggest that theories of ethics, when applied in a practical context, can complement each other not *in spite* but *because* of the different angles they propose for moral evaluation. The combination of values and ethics in IT innovation opens up many possibilities for new methods and a new basis for a better design of technological products and services. And still, several aspects have yet to be more thoroughly investigated, and some may lead to more fundamental questions. Among them are questions of how we should understand an ethics of information technology design (Myers & Venable, 2014) and the underlying relations between humans and technology (Sharon, 2014) as well as between design and use (Brigham & Introna, 2007). Frauenberger (2019) has recently argued that the field of HCI needs a paradigm shift away from creating a fit between technology, users and the design of an interface towards designing meaningful human-technology *relations*. In the following section, I want to expand on the relevance of this point for future developments in technology design and disciplines concerned with the theoretical analysis of technology-related questions.

5.3.1. Views of the Human-technology Relation

The human-technology relation has long been studied by interdisciplinary programs such as STS or the philosophy of technology, but has only more recently been discussed in relation to technology design (Coeckelbergh, 2013; Frauenberger, 2019; Sharon, 2014). Frauenberger (2019) states that "we need to further develop such techniques to enquire into, understand and work with the many ways in which humans and things mutually depend on each other" (p. 20) to "create spaces in which we negotiate desirable futures" (p. 21) in participatory design practices. Many approaches in IT ethics, design, engineering, and development aim to include stakeholders in the design and development process of new technologies to acknowledge that individuals differ in their needs, goals and general views regarding technology. However, the relation of human beings and technology is bidirectional: “we create things that very often alter the ecology of our minds, as well as shape the boundaries of our thinking and the ways we understand and encounter the world” (Malafouris, 2014, p. 140). And the other way around, an understanding of human beings and their general abilities, needs, and goals is also implicit in our expectations of technology. However, the research on the impact of different views of the human, technology and the human-technology relation on the design of (new) technology is scarce.

Informative findings for how individuals involved in the technology design process differ in their views of humans and technology come from a research group that empirically investigated the role of privacy in information systems engineering. Carew and Stapleton (2014) found that important beliefs and attitudes in system development can be represented along two dimensions. The first dimension (labeled “humanist-existentialist”) combines the belief in a free will and the responsibility for one’s choices (existentialist aspects) with a concern for society and a broad humanitarian perspective that places the human at the center and shows concern for a person’s values, rights, and dignity (humanist aspects). The second dimension (“technocentrist-industriofatalist”) puts the focus on economic pursuits as well as on technical aspects such as functionality. Although this two-dimensional perspective has emerged in the information privacy context, it fits well with the wider diverging paradigms in current technology design approaches, which attribute different levels of appreciation to humans and technology.

On the one hand, we find approaches such as human-centered design (Norman, 2013), goal-directed design (Cooper et al., 2014), VSD (Friedman et al., 2006), VBE (Spiekermann, 2023) and participatory design (Kuhn & Muller, 1993). All these approaches share an empathic attitude towards human needs and capabilities that they seek to include in the design process. On the other hand, the far-reaching possibilities of technological development have nurtured a technological optimism that focuses on capabilities and potentials on the part of technology. Silicon Valley is one of the places of origin of this techno-centered perspective, which often sees information as the driving resource (Duff, 2016). Extreme techno-centered developments such as transhumanism (Bostrom, 2009) seek to move beyond limitations given by the physiological and cognitive setup of human beings through technological means. To make this possible, transhumanists support investments in technology development areas subject to complex ethical and legal discussions such as biotechnology, nanotechnology, and artificial intelligence.

These different approaches to technology show the important influence that assumptions about human nature and the role of technology can have on the design of technological artefacts. In the following, I want to explore three selected dimensions to delineate views of human nature that potentially influence how we perceive, use, and design technology. Any concept of human nature typically captures basic assumptions about humans in an image, either to determine what is right (normative function) or to show what is characteristic of humans (descriptive function; Düwell, 2011). Whether human nature itself is fixed or variable is yet under debate, which is why a concept of human nature typically reflects the assumptions, reflections and concerns of a certain era, discipline, or cultural group.

The German psychologist Fahrenberg (2007) provides one of few interdisciplinary theoretical works on different views of human nature. Based on psychological, biological, intercultural, and religious perspectives, he defines a concept of the human as "the aggregate of assumptions and beliefs regarding *what the nature of human beings is*, how they should *live in their social and material environment* and which *values and goals* their lives should have" (p. 9, translation and emphasis by author). This definition suggests three core dimensions that can be explored with regard to how they play out in technology design and use: first, the natural constitution of human beings; second, the position of human beings within their environment; and third, human values. While major philosophical works have presented elaborate ideas on each of these topics, I want to conclude this thesis with a discussion of these three dimensions by bringing together perspectives from different times, disciplines and discourses in a critical but necessarily limited overview.

5.3.2. Where to Draw the Line? Body, Mind, and Technological Enhancements

One of the characteristics that traditionally differentiates human beings from other living creatures is their self-awareness and rich mental life. Rooted within this feature of the human mind is the question on what gives rise to mental experiences and the role of the body. Depending on how and where the line between the subjective mental life and the physical world is drawn, different concepts of human beings, their worth and their position in their environment can be formed. Especially the line between mind and body influences the attitude towards emerging technologies such as bio-technologies (Sharon, 2014). Those with a predominantly optimistic view of technology and its potential effects on the human constitution welcome or even celebrate human enhancement by means of emerging technologies, while those with a rather pessimistic view condemn it. A third position suggests an alternative view on human nature overall, and questions the strict separation of humans and technology.

Proponents of the view that the body is a mere biological substrate of the mind often recognize the physical vulnerability of humans as a weakness that technology could help to overcome. For example, transhumanists (e.g., Bostrom, 2009) welcome emerging technologies and their application for treatment as well as for enhancement purposes. They emphasize the potential of technology and see the ultimate goal of human development in the transcendence of human boundaries and limitations. At the other end of the spectrum, we find groups called “bioconservatives” (term used by Sharon, 2014) or “infoconservatives” (term used by Coeckelbergh, 2013), who want to protect what naturally constitutes and characterizes humans and thus support “natural” strategies for human development and personal growth, such as education. Proponents (e.g., Fukuyama, 2002) criticize technological developments and innovations that alter human capabilities and characteristics and argue for the protection of the boundaries between humans and technology.

These two opposing positions on biotechnologies shed light on how different views of the human constitution influence the perception of technology, its design and use. Still, they both share the view that there is something fixed that constitutes human nature. Outside of this view is the existential-phenomenological account of Coeckelbergh (2013), who argues that there is no clear boundary between the natural and technology, that human beings have always been shaped by technology as much as by the social and historical context, and that there is no fixed notion of human nature. He sees the impact of technological enhancement on what some describe as “human nature” as more complex than assumed in the debate of transhumanists vs. bio/infoconservatives. In his view, any enhancement will produce new vulnerability, which is why we need to discuss *how* human beings are influenced rather than debating whether this influence changes human *nature*. Sharon comes to a similar conclusion, designating both positions as “humanism” as they emphasize the uniqueness of the human and thus separate the human from “the rest”, be it animals, nature, or technology (Sharon, 2014).

The argument that opening up the dichotomy of humans and technology engenders radical rethinking and restructuring of categories is not new. It is what Donna Haraway (1991) tried to illustrate with her idea of the “cyborg”, which challenges traditional categories such as the human-technology dichotomy. Similarly, philosophers of technology such as Don Ihde or Peter-Paul Verbeek have emphasized the mediating role of technology for how humans relate to the world and to each other. Verbeek (2005) argues that human nature is never purely "natural" but always includes technological aspects, which is why we need to rethink these categories and their relation, as proposed by Frauenberger (2019) for the field of HCI.

5.3.3. Autonomy Reconsidered: Humans and Their Environment

In the history of philosophy, discussing the *state of nature* of humans emerged during European colonialism when groups of people that had lived undetected by European civilization were discovered. This experience gave rise to the idea that humans generally have a natural state outside the influence of society and inspired liberal thinkers. According to Thomas Hobbes and John Locke, humans are isolated individuals who exist completely independently from one another and from nature, i.e., in radical autonomy (Deneen, 2018). Liberalism still influences much of our Western thinking and views of technology. From a liberal view, technology increases human freedom by extending human capabilities and compensating inequalities and supports humans in manipulating and controlling their natural environment. This idea is largely owed to Francis Bacon and has taken on new dimensions with the technologies available today (Deneen, 2018).

However, liberalism is often criticized for not taking into account that humans have developed and evolved with their natural environment and are embedded in social groups (e.g., family, friends, colleagues, society, community, state). From an alternative perspective, humans have become deeply social beings who have learned to appreciate support and show solidarity because of their dependence on members of the community (Tomasello, 2014); they are *situated* and *embedded* and thus perceive and act *in the world* (Fuchs, 2018). Thus, social and cultural aspects do not only influence the human understanding of morals, norms, habits, and goals, but have also shaped the evolution of human cognitive abilities. Phenomenological accounts that stress the relation between human beings and their environment have seen an increase in popularity and have influenced current thinking (e.g., Fuchs, 2018; Sharon, 2014).

However, the concept of human autonomy and the related assumed independence from the social and natural environment still exists in many disciplines. Especially economics at large is still stuck in the image of the human as an autonomous, calculating individual, the *homo oeconomicus* (Raworth, 2017). Thus, the assumptions of basic economic models stand in contrast with the concepts that stress the importance of the social and natural environment for human beings. This, in turn, influences how we design and envision future technologies, seeking to further extend our control over ourselves and our environment, both social and natural. If we take our situatedness and embeddedness seriously, we need to consider the wider effects that such technologies could cause with regard to our cognitive and social capabilities.

5.3.4. Human Values and Technology

Values stress the relationship and interaction between the human as a valuing organism and the world as value-bearing environment (Fuchs, 2020). Recent research has shown that laws, principles, declared goals and obligations that have been put forward in various fields (including design, engineering, law, psychology, philosophy, and ethics) can be brought together in terms of values (Winkler & Spiekermann, 2019). I have applied the resulting taxonomy with five dimensions of sustainability (individual, social, technical, economic, and environmental) in the classification of values in the empirical research that I presented above (see Section 3.4.4 ”Value Classes”). These value classes provide a good starting point for discussing views of humans and technology. In the following, I want to briefly discuss individual values, social values, environmental values, technical values, and economic values with regard to their relevance for the human-technology relation.

Individual values cover basic and higher-order preconditions for a good life. They thus comprise health, safety, freedom, and property as well as education, knowledge, and pleasure (Winkler & Spiekermann, 2019). In psychology, these values are usually framed as needs, and several theories have addressed how they drive human behaviour. One of the best-known models is Maslow’s theory of needs (Maslow, 1943), which proposes a hierarchical structure that covers physiological needs, safety needs, love needs, esteem needs, and the need for self-actualization at the very top. While user-centered design approaches typically seek to account for individual needs, they often focus on mere ease of use and ergonomic factors. In contrast, a focus on individual values and virtues incorporates a moral dimension in the consideration of the human-technology relation (Vallor, 2016).

Different views of the social human condition result in a different appreciation of social values. For example, the values of freedom, safety, and justice can stand in contrast with the values of equality, dignity, trust, and community. While human rights aim to protect every human’s dignity independently of the individual’s capacities, abilities, etc., liberal thinkers typically stress human freedom. Digital products and services cater to social values in complex ways. In the introduction, I reported empirical findings on how information and communication technologies make digital communication easier and faster while at the same time reducing personal interactions and meetings. In contrast, a stronger community is called for to ensure a more democratic and socially just political (Monbiot, 2017) and economic life (Raworth, 2017). Thus, an adequate understanding of humans as social beings can help to translate what is needed for a functioning society into requirements for products and services that are advertised and put on the market.

Related to this is the perception of environmental values such as biological diversity and a respect for nature (Winkler & Spiekermann, 2019). For most of our evolutionary history, the natural environment has determined the conditions of human life, influencing the genetic constitution of human beings and thus human capacities and limitations. In modernity, a view of human superiority over nature emerged. Influenced by scholars from the liberal tradition such as Francis Bacon and Thomas Hobbes, humans were described as having strong control over nature, including their own nature. Today, humans face the challenge of maintaining an environment that provides space for natural life, including humans, animals, and plants. In the Anthropocene, the age where human activity predominantly determines the fate of the earth, any human-centered approach is challenged by the need to take the natural environment into account (Velden, 2018). In line with this is a view that attributes a unique stewardship role to humans, a position of responsibility in the world. No matter whether humans are seen in a position superior to their surroundings or not, the question remains whether this superiority is accompanied by an attitude of power or an attitude of care, which results in a different appreciation of environmental values—and thus a different starting position for the design and development of technologies. The current climate crisis and the multitude of technological devices being produced force us to consider any technology as an ecology that includes design, materials, humans and non-humans as much as politics and motivate environmentally friendly and sustainable technological innovations (Velden, 2018).

Values have long made their way into technology design and development (e.g., Brey, 2010; Friedman and Kahn, Jr., 2003). While usability, maintainability, and efficiency are typical values that technologies foster, values with social import such as information privacy have attracted wider attention only more recently. In Europe, this has been accompanied by the application of the new GDPR in 2018 (The European Parliament and the Council of the European Union, 2016). The example of information privacy can very well illustrate how individuals' views and beliefs affect their behaviour. Research conducted at our institute has shown that engineers' pessimist beliefs about the feasibility of information privacy come with a decreased motivation to implement privacy mechanisms (Bednar et al., 2019; Spiekermann et al., 2018a). Carew and Stapleton (2014) express even wider concerns by showing that in system development, interests in human, social, and moral issues are diametrically opposed to interests in technical issues and functionality. Thus, a sustainable model of technology production, use, and interaction needs to conciliate technical values with individual, social, and environmental values.

Economics is one of few disciplines that has designed its own view of human nature. The image of homo oeconomicus that pictures the human as "standing alone, money in hand, calculator in head, and ego in heart" (Raworth, 2017, p. 96) still prevails in many economic textbooks, theories and in policy making—and has resulted in specific economic values. The strive to maximize utility, perfect knowledge, and foresight were added to the idea of human beings as rational, autonomous individuals, to create an image of the ideal consumer—an initially descriptive model that soon became prescriptive. While this image was later criticized by important figures in economics, it has contributed to the development of current economic values that focus on profit maximization through efficiency, productivity, and innovation. In her book "Doughnut Economics", Kate Raworth (2017) emphasizes that a new image that is fit for the twenty-first century is needed, as well as new economic values that seek to re-situate human well-being within the social and ecological boundaries determined by human needs and the natural environment's capacities.

5.3.5. Looking Ahead: A Paradigmatic Shift?

The natural and technological environment offers a variety of ways for human beings to live, grow and develop. Technology design that wants to acknowledge human aspects needs to be flexible to take into account the many regards in which humans and technology influence each other. In this final chapter of my thesis, I have delineated discourses on human nature and technology that seem relevant for further developments in technology design and innovation.

Interestingly, many debates start from the assumption that the nature of human beings can be captured in specific images that delimitate human nature from the natural and material environment. These positions are challenged by accounts that emphasize the interrelatedness of mind and body, humans and the natural environment, and humans and technology. Human-centered design can certainly profit from considerations on how to place their approach "within the doughnut" (Raworth, 2017; Velden, 2018), that is, to consider both human and environmental restrictions. However, Sharon (2014) and Coeckelbergh (2013) argue that an ideological view on the human in terms of "human nature" or "humanism" needs to be overcome in order to make room for a view of humans and technology as inherently interrelated categories. Putting the split between mind and body, human and technology, and human and world into perspective can be critical in reconsidering the role of technology for human beings. This is in line with Frauenberger's (2019) call for a new HCI paradigm that allows for a more flexible understanding of the human-technology (inter-)relation.

To conclude, the debates on what constitutes the human naturally, how human beings are related to their environment, and what implications this has for their actions and responsibility as well as for the role of technology clearly show that implicit theories and assumptions can influence how technology is designed and used. While I only offer a preliminary analysis of positions and arguments in this final chapter, further research—both theoretical and empirical—will help to further explore different accounts and discuss their influence on current understandings of the human-technology relation as well as on future technological developments. A better understanding of implicit beliefs regarding humans and technology can inform research and practice in the fields of technology ethics, design, and engineering and can open up space for a positive reconceptualization of both what it means to be human and the role of technology.

6 Conclusions

In this thesis, I investigated a method that aims at an ethically grounded and value-based information technology design. Results of the empirical study show that different theories of ethics can be employed in a technology design and innovation process as unique perspectives on the good and right, supporting an ethically grounded understanding of values. Based on results of a mixed-method analysis applying both qualitative and quantitative methods, I draw several conclusions that are relevant for current innovation practices and theoretical assumptions in IT ethics, but also for both theoretical and practical aspects of value-oriented design and research projects. I also highlight how the results provide an empirical legitimatization of the VBE approach (Spiekermann, 2023) and the related IEEE 7000™ standard model process for ethical system design (IEEE Computer Society, 2021; ISO, 2022).

In brief, I conclude that values represent a useful and important concept that can guide ethical technology design (Section 6.1). What is more, utilitarianism, deontology, and virtue ethics can jointly be applied in a creative and practical setting and together provide a pluralist ethical framework for value elicitation, resulting in a more holistic view on relevant values that represent high moral principles and support sustainability in various dimensions (Section 6.2). Additionally, a value-based approach based on ethical perspectives can broaden the classic understanding of "value" within the business context and promote technology innovation beyond basic functionalities and technical capabilities offered to customers (Section 6.3). Still, it seems limited in influencing an individual's beliefs and assumptions with regard to technological innovation, with a negligible impact on the participants' investment decisions. In the following, I summarize these results and their implications.

6.1 Values as a Bridge Between Technology Ethics and Design

In the theoretical part of the thesis (Chapter 2), I present insights into the understanding of values in the information systems context and related areas of research, from which several requirements can be deduced. First, in order to fully acknowledge the potential of this concept, values need to be understood as moral principles that can comprise intrinsic values, virtues (i.e., moral values carried by a person) and instrumental values. This differentiation has been proposed and discussed before (e.g., van de Poel, 2009) and VBE has systematically implemented it into a technology design approach by relating instrumental values to the intrinsic core values that should be prioritized for a technology design (Spiekermann, 2023). Second, serious endeavours to provide technology design and development with values need to consider both potential value benefits as well as value harms. VBE has taken up this consideration by exploring both positive and negative value potentials of a system (Spiekermann, 2023). Such a balanced view of a technology's impact on values fits well within the technology design context as it combines the critical view of traditional IT ethics on potential risks with the aim of design and innovation to come up with new ideas and solutions to a problem. Third, the context-specificity of values needs to be considered to ensure a reliable and valid understanding of relevant values, as has been discussed before (e.g., Le Dantec et al., 2009). My findings show that this can be supported by the empirical discovery or elicitation of values at an early stage of the design and innovation process, as proposed by VBE and VSD. Lastly, relating values to various dimensions of sustainability can help to broaden the value focus and address various social and societal challenges.

While these findings open up a promising field for value-based design and innovation, I am also aware of several challenges and potential limitations of the approach. Most importantly, the participants in the presented empirical study struggled with applying the core idea of the concept of values and virtues, which is why we had to conduct thorough and time-intensive qualitative analyses of their idea descriptions. What is more, findings on how the resulting value analyses affect investment decisions suggest that students of information systems had already had a predominantly positive and optimistic view of the potential that digital technologies bring to the market and thus to customers and society, which could hardly be influenced by a value-based analysis of possible benefits and harms.

Taken together, the findings I present in this thesis strongly support the claim that values help to bridge the gap between theoretical ethical considerations and design and innovation practices. Also, they show that theories of ethics maintain their unique ethical perspectives when applied in a creative setting. However, more research is needed for a better understanding of how these potentials can be operationalized without falling into pitfalls that open up when dealing with complex matters such as information technology, values, and ethical implications. Finally, current discourses in technology design and ethics open up new views on the human-technology relation and thus the role of technology and its design.

6.2 A Pluralist Ethical Framework for Value Elicitation

Every theory of ethics contributes a unique asset to the discussion of what is right and wrong in technology design. In this thesis, I investigated three normative theories and their potential to support an ethics-based value elicitation process. Results presented in Section 4.1 show that the perspectives of utilitarianism, virtue ethics, and deontology lead to the identification of a broad variety of context-specific moral values that cater to various sustainability dimensions and go beyond the value themes listed by public institutions and tech corporations. Moreover, every ethical perspective contributes to the identification of different values in unique ways.

Results suggest that utilitarianism offers a powerful perspective by inspiring a high number of value ideas for a specific context and covers various value dimensions, leading to an "expansion" (Mingers, 2001) of value ideas. Virtue ethics complements this set of ideas with a focus on the affected stakeholders' character and good behaviour, resulting in a set of diverse virtues that contribute to an individual's sustainable development within their social context. Virtue ethics seems to contribute especially to the discovery of "fresh" value ideas and thus increased "creativity" (Mingers, 2001) in terms of originality. Deontology inspired the highest proportion of intrinsic value ideas with a focus on social sustainability and validates important values and virtues mentioned in the foregoing analyses, supporting "triangulation" (Mingers, 2001).

Examplary ideas for the telemedicine platform show how the ethical theories lead to qualitatively different value ideas. In traditional technology roadmapping, most participants thought of digital services that are efficient and easy to use, supporting the basic functionalities that the information system should offer to customers and users. In the roadmap, the participants suggested to make the telemedicine platform secure by implementing data security mechanisms to prevent system hacks, design a user-friendly interface and connect patients to a wide range of doctors in various locations.

Utilitarianism then highlighted the dominant values that the basic functionalities of the telemedicine platform cater to—health and efficiency—but also made the participants consider an important mainstream value at stake, i.e., privacy. From a utilitarian perspective, the participants considered potential positive effects of the telemedicine platform on the patients' health by focusing on faster and better treatments based on optimal patient-doctor matches, better medical information access, and accurate diagnoses. Also, they wanted to make the platform efficient by optimizing the patient-doctor matches (through digital customer services, and an appointment scheduling system) and the access to patient's medical history. Next to these beneficial value effects and related technical measures, they also feared a potential breach of privacy of the patient's digitalized personal data, proposing encryption, access control, and transparency on data usage to mitigate this risk.

With the virtue ethics perspective, the participants took a completely new perspective on the telemedicine platform with a strong focus on the human beings involved in the interactions supported by the platform. The participants hoped that public ratings for doctors, privacy frameworks, and transparent information on how the recommendation system works as well as high-quality interaction with the doctors would increase the patients' trust in the platform and the medical service it offers. However, they also felt that the primarily digital interactions could endanger the truthfulness and honesty of patients, which the participants wanted to counteract with more transparency, e.g., information on a patient's medical history or access control for specific prescriptions. Many participants also thought of the doctors' commitment as an important virtue that they wanted to foster through free access to the platform, a wide patient base and a reward system. It is questionable whether these organizational and technical measures can actually support human growth in the form of virtuous behaviour and character and avoid leading patients and doctors morally astray in their actions. Still, the virtue ethics perspective helped to uncover completely new issues connected to the telemedicine platform's use with high moral relevance that had not been in focus before.

The deontological perspective then made many participants consider health as the top value that would be fostered through the telemedicine platform as it offered access to doctors and better health information. Moreover, the participants again emphasized the already aforementioned privacy issues in the deontological analysis. Thus, both the key value benefit and potential harm were put into focus by the deontological lens on moral duties and principles.

These results illustrate that each theory of ethics offers a unique perspective in the identification of ethical issues and value potentials of a technology, providing a strong empirically founded argument for a pluralist ethical basis for values in technology design. When dealing with design situations that are "inherently complex and multidimensional" (Mingers, 2001, p. 243), such a strong pluralism combining a range of ethical perspectives seems especially beneficial to capture "the full richness of the real world".

Taken together, I conclude that the identification of relevant values should not be open to any theory of one's preference (as currently suggested in VSD; Friedman & Hendry, 2019) nor based on only one ethical perspective. The theoretical framework guiding an ethics-based value elicitation process needs to be chosen consciously and carefully. Different theories of ethics inspire the identification of different sets of values that are relevant for a specific technology and its context of use, which supports their joint application as proposed by VBE (Spiekermann, 2023). Together, they contribute to a richer and more reliable understanding of the real world (Mingers, 2001).

6.3 Increased Creativity and Biased Thinking in Traditional IT Innovation

The digital transformation of the economy pressures companies to come up with convincing value propositions for investors and customers and defend a competitive position in an environment of start-ups that want to digitally disrupt existing markets. While creativity typically abounds in this environment, innovation needs to accommodate not only hyped technological advancements, but also morally relevant values. In Section 4.2, I have shown that traditional technology roadmapping practices are limited in the extent to which they can achieve this, as they focus too much on technology strategy and an abstract user market. Findings suggest that an ethics-based approach employing the perspectives of utilitarianism, virtue ethics, and deontology could serve as a potential addition to traditional technology roadmapping to foster creative thinking around values and increase sensitivity to potential stakeholder harms. The rich spectrum of values that the participants discovered for each technology shows how much there is to discover beyond mainstream values. Grounded in ethical perspectives, the value-based approach that I investigated and that forms the core of VBE (Spiekermann, 2023) not only takes the empirical value discovery phase seriously (Le Dantec et al., 2009), but also adds a theoretical framework that warrants the moral import of the identified values.

Compared to technology roadmapping, the participants came up with more than three times as many value ideas in the ethics-based approach and were also more flexible in their value-related thinking, acknowledging more value classes linked to sustainability dimensions including individual and social values. They were also more original, departing from values such as IT security or ease of use by uncovering unique value ideas, for instance, on how to foster community, flexibility, or human contact. The traditional technology roadmapping approach elicited ideas involving values with a technical and economic focus (e.g., IT security or efficiency). When employing the ethics-based approach, however, the participants acknowledged higher principles (e.g., freedom or personal growth). These results not only provide insights into the creative power that can be unleashed by taking different ethical perspectives on values in specific technology contexts, but also show the usefulness of a quantitative operationalization in evaluating and comparing innovation methods in terms of creative output. What is more, I hope that the elaborate methodological approach that I chose, employing both qualitative and quantitative analysis methods, can support future value-oriented projects. The detailed category system that resulted from the qualitative analyses could be especially useful by serving as an exemplary inventory of values that can be used as a reference or "heuristic" (Borning & Muller, 2012) by information systems researchers, scholars, and practitioners.

Professional codes of ethics have a long history in the field of computer science and recent ethical guidelines for AI have increasingly been presented. Both approaches contribute to a more ethically aligned design and development of technology. However, results presented in Chapter 4 show that the consideration of virtuous behaviour and personal development of involved and affected stakeholders is as important as the consideration of a variety of values among different dimensions (i.e., economic, social, individual, technical and environmental). Thus, any approach that restricts itself to the mere implementation of a list of technical values or only focuses on specific groups or individuals necessarily ignores important areas of ethical import that could help to further improve a technology's design. A value-based approach acknowledges 1) that values are carried both by artefacts and human beings and 2) that values represent a variety of moral concepts and principles that contribute to a sustainable future for individuals in their economic and social context as well as for technical developments and the natural environment.

In Section 4.3, I presented results based on the yes/no decision patterns as well as the explanations given by 18 student teams that had analysed the telemedicine platform and its prospects for a potential investment. Qualitative findings suggest that a few core observations can explain the teams' dominantly positive investment decisions. Overall, I found that the benefits and harms identified in the ethical analyses had only a minor effect on the participants' decisions and that the potential harms were often blocked out in favour of benefits. By contrast, personal beliefs combined with the product's technological features strongly affected the overall investment decision process. Most importantly, participating students of information systems seem to have been biased towards an overall positive conception of IT innovation. The participants were typically forward-looking, focusing on the benefits the product could bring in the future rather than on current drawbacks. They emphasized that the telemedicine platform had the possibility to make a difference in the healthcare industry due to its digital features.

Crossing the conclusions from literature with my empirical findings, I introduced the term “pro-technology innovation bias” to describe the participants’ confident belief in a new technology’s success while deliberately or unintentionally neglecting potential drawbacks and harmful effects that currently exist. This sheds some light on people’s tendency to associate new technology with radical improvements and success, which might have large effects on organisational settings. Although it has been argued that specific values, or more precisely, value harms, can support arguments against a technology’s development altogether, a more detailed discussion of selected values that had been assessed as more important is overall missing in the participants’ value analyses. This hints at a “quantity over quality” bias next to the overall optimistic view of technology and innovation.

Of course, the specific context (a university course, predefined time frames for the tasks, specific instructions, the investigated IT products in the case studies) heavily influences how the participants conducted the different analyses. Still, the findings I present above show that potential biases need to be taken into account when individuals and teams want to evaluate technology design from a value-based perspective. To the best of my knowledge, a discourse on potential pitfalls of value-oriented design methods is largely missing in the literature. This opens up space for future research projects that do not only serve practical purposes but can also contribute to current knowledge of decision-making and biases. I encourage further research to investigate the existence of a pro-technology innovation bias in order to provide the analysis of IT investment decisions with additional explanatory power and to contribute to a more balanced view on new technology and its effects.

References

ACM. (2020). ACM code of ethics and professional conduct.

Agre, P. E. (1997). *Computation and human experience*. Cambridge: Cambridge University Press.

Ahmed, P., & Shepherd, C. (2012). *Innovation management*. New York: Financial Times/Prentice Hall.

Ahmed, Pervaiz, & Shepherd, C. (2010). Technology strategy. In *Innovation Management: Context, strategies, systems and processes* (pp. 127–161). Harlow: Financial Times, Prentice Hall.

Aizenberg, E., & van den Hoven, J. (2020). Designing for human rights in AI. *Big Data and Society*, *7*(2). https://doi.org/10.1177/2053951720949566

Albrechtslund, A. (2007). Ethics and technology design. *Ethics and Information Technology*, *9*(1), 63–72. https://doi.org/10.1007/s10676-006-9129-8

Albright, R. E., & Kappel, T. A. (2003). Roadmapping in the corporation. *Research-Technology Management*, *46*(2), 31–40. https://doi.org//10.1080/08956308.2003.11671552

Alexander, L., & Moore, M. (2020). Deontological ethics. In E. N. Zalta (Ed.), *Stanford Encyclopedia of Philosophy* (Winter 20). Retrieved from https://plato.stanford.edu/archives/win2020/entries/ethics-deontological/

Alonzo, R., Hussain, J., Stranges, S., & Anderson, K. K. (2021). Interplay between social media use, sleep quality, and mental health in youth: A systematic review. *Sleep Medicine Reviews*, *56*, 101414. https://doi.org/10.1016/j.smrv.2020.101414

Amabile, T. M. (1982). Social psychology of creativity: A consensual assessment technique. *Journal of Personality and Social Psychology*, *43*(5), 997–1013. https://doi.org/10.1037//0022-3514.43.5.997

Amabile, T. M. (1997). Motivating creativity in organizations: On doing what you love and loving what you do. *California Management Review*, *40*(1), 39–58.

Anderson, E. (1993). *Value in ethics and economics*. *The Philosophical Review* (Vol. 104). Cambridge, MA & London: Harvard University Press.

Anderson, S. P. (2011). *Seductive interaction design: Creating playful, fun, and effective user experiences*. Berkeley: Ne Rriders.

Arendt, H. (1965/2006). *Eichmann in Jerusalem: A report on the banality of evil*. New York:

Penguin Classics.

Aristotle. (2004). *Nicomachean ethics*. (R. Crisp, Ed.). Cambridge University Press.

Association for Computing Machinery. (2018). *ACM code of ethics and professional conduct*. Retrieved from https://www.acm.org/binaries/content/assets/about/acm-code-of-ethics-and-professional-conduct.pdf

Awad, E., Dsouza, S., Kim, R., Schulz, J., Henrich, J., Shariff, A., … Rahwan, I. (2018). The Moral Machine experiment. *Nature*, *563*, 59–64. https://doi.org/10.1038/s41586-018-0637-6

Bacon, C. J. (1992). The use of decision criteria in selecting information systems/technology investments. *MIS Quarterly*, *16*(3), 335. https://doi.org/10.2307/249532

Barkhordari, R., & Willemyns, M. (2016). Young adults' construction of social identity on Facebook: A structural equation model. In *Proceedings of the 3rd European Conference on Social Media*.

Batey, M. (2012). The measurement of creativity: From definitional consensus to the introduction of a new heuristic framework. *Creativity Research Journal*, *24*(1), 55–65. https://doi.org/10.1080/10400419.2012.649181

Bednar, K. (2020). Exploring human nature in a technology-driven society. In D. Kreps, T. Komukai, T. V. Gopal, & K. Ishii (Eds.), *Human-centric computing in a data-driven society: Proceedings of the 14th IFIP TC 9 International Conference on Human Choice and Computers, HCC14 2020* (pp. 281–290). Cham: Springer. https://doi.org/10.1007/978-3-030-62803-1

Bednar, K., & Spiekermann, S. (2018). Aware but not in control: A qualitative value analysis of the effects of new technologies. In D. Kreps, C. Ess, L. Leenen, & K. Kimppa (Eds.), *This changes everything - ICT and climate change: What can we do? Proceedings of the 13th IFIP TC 9 International Conference on Human Choice and Computers, HCC13 2018, held at the 24th IFIP World Computer Congress, WCC 2018, Poznan, Poland, September 19–2* (pp. 202–218). Cham: Springer. https://doi.org/10.1007/978-3-319-99605-9

Bednar, K., & Spiekermann, S. (2020). The power to design: Exploring utilitarianism, deontology, and virtue ethics in three technology case studies. In A. M. L. P. Jorge Pelegrín-Borondo, Mario Arias-Oliva, Kiyoshi Murata (Ed.), *Paradigm Shifts in ICT Ethics: Proceedings of the ETHICOMP 2020* (pp. 396–399). Logroño: Universidad de La Rioja.

Bednar, K., & Spiekermann, S. (2022). Eliciting values for technology design with moral philosophy: An empirical exploration of effects and shortcomings. *Science, Technology, & Human Values*, 1–35. https://doi.org/10.1177/01622439221122595

Bednar, K., Spiekermann, S., & Langheinrich, M. (2019). Engineering Privacy by Design: Are engineers ready to live up to the challenge? *The Information Society*, *35*(3), 122–142. https://doi.org/10.1080/01972243.2019.1583296

Bentham, J. (1789/1907). *An introduction to the principles of morals and legislation*. Oxford: Clarendon Press.

Berenbach, B., & Broy, M. (2009). Professional and ethical dilemmas in software engineering [Cover feature]. *Computer*, 74–80. https://doi.org/10.1109/MC.2009.22

Billieux, J., Maurage, P., Lopez-Fernandez, O., Kuss, D. J., & Griffiths, M. D. (2015). Can disordered mobile phone use be considered a behavioral addiction? An update on current evidence and a comprehensive model for future research. *Current Addiction Reports*, *2*, 156–162. https://doi.org/10.1007/s40429-015-0054-y

Błachnio, A., Przepiórka, A., & Pantic, I. (2015). Internet use, Facebook intrusion, and depression: Results of a cross-sectional study. *European Psychiatry*, *30*, 681–684. https://doi.org/10.1016/j.eurpsy.2015.04.002

Boaden, R., & Lockett, G. (1991). Information technology, information systems and information management: Definition and development. *European Journal of Information Systems*, *1*(1), 23–32. https://doi.org/10.1057/ejis.1991.4

Boenink, M., & Kudina, O. (2020). Values in responsible research and innovation: From entities to practices. *Journal of Responsible Innovation*, *7*(3), 450–470. https://doi.org/10.1080/23299460.2020.1806451

Bonnín Roca, J., Vaishnav, P., Morgan, M. G., Mendonça, J., & Fuchs, E. (2017). When risks cannot be seen: Regulating uncertainty in emerging technologies. *Research Policy*, *46*, 1215–1233. https://doi.org/10.1016/j.respol.2017.05.010

Borning, A., & Muller, M. (2012). Next steps for value sensitive design. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI'12)* (pp. 1125–1134). ACM. https://doi.org/10.1145/2207676.2208560

Bos, C., Walhout, B., Peine, A., & van Lente, H. (2014). Steering with big words: Articulating ideographs in research programs. *Journal of Responsible Innovation*, *1*(2), 151–170. https://doi.org/10.1080/23299460.2014.922732

Bostrom, N. (2009). The Transhumanist FAQ. In D. M. Kaplan (Ed.), *Readings in the philosophy of technology* (2nd ed., pp. 345–360). Lanham, MD: Rowman & Littlefield Publishers.

Brady, F. N., & Dunn, C. P. (1995). Business meta-ethics: An analysis of two theories. *Business Ethics Quarterly*, *5*(3), 385–398. https://doi.org/10.2307/3857390

Braithwaite, V., & Blamey, R. (1998). Consensus, stability and meaning in abstract social values. *Australian Journal of Political Science*, *33*(3), 363–380. https://doi.org/10.1080/10361149850525

Brewer, T. (2009). *The retrieval of ethics*. New York: Oxford University Press.

Brey, P. (2005). Artifacts as social agents. In H. Harbers (Ed.), *Inside the politics of technology: Agency and normativity in the co-production of technology and society*. Amsterdam: Amsterdam University Press.

Brey, P. (2010). Values in technology and disclosive computer ethics. In L. Floridi (Ed.), *The Cambridge handbook of information and computer ethics* (pp. 41–58). Cambridge University Press.

Brey, P. (2012). Anticipating ethical issues in emerging IT. *Ethics and Information Technology*, *14*, 305–317. https://doi.org/10.1007/s10676-012-9293-y

Brey, P. (2015). Design for the value of human well-being. In J. van den Hoven, P. Vermaas, & I. van de Poel (Eds.), *Handbook of ethics, values, and technological design: Sources, theory, values and application domains* (pp. 365–382). Dordrecht: Springer. https://doi.org/10.1007/978-94-007-6970-0

Brigham, M., & Introna, L. D. (2007). Invoking politics and ethics in the design of information technology: Undesigning the design. *Ethics and Information Technology*, *9*, 1–10. https://doi.org/10.1007/s10676-006-9131-1

Brooks, S. (2015). Does personal social media usage affect efficiency and well-being? *Computers in Human Behavior*, *46*, 26–37. https://doi.org/10.1016/j.chb.2014.12.053

Brown, T. (2009). *Change by design: How design thinking transforms organizations and inspires innovation*. New York, NY: Harper Collins. https://doi.org/10.1017/CBO9781107415324.004

Camillus, J. C., Bidanda, B., & Mohan, N. C. (2017). *The business of humanity: Strategic management in the era of globalization, innovation, and shared value*. New York: Routledge. https://doi.org/10.4324/9781315277622

Caplan, S. E. (2003). Preference for online social interaction: A theory of Problematic Internet Use and psychosocial well-being. *Communication Research*, *30*(6), 625–648. https://doi.org/10.1177/0093650203257842

Carew, P. J., & Stapleton, L. (2014). Towards empathy: A human-centred analysis of rationality, ethics and praxis in systems development. *AI and Society*, *29*(2), 149–166. https://doi.org/10.1007/s00146-013-0472-0

Caviola, L., Mannino, A., Savulescu, J., & Faulmüller, N. (2014). Cognitive biases can affect moral intuitions about cognitive enhancement. *Frontiers in Systems Neuroscience*, *8*(195), 1–5. https://doi.org/10.3389/fnsys.2014.00195

Chang, R. (2015). Value pluralism. In *International Encyclopedia of the Social & Behavioral Sciences* (pp. 21–26). https://doi.org/10.1016/B978-0-08-097086-8.63090-8

Chang, V., Li, Z., & Ramachandran, M. (2019). A review on ethical issues for smart connected toys in the context of big data. *COMPLEXIS 2019 - Proceedings of the 4th International Conference on Complexity, Future Information Systems and Risk*, 149–156.

Chau, D. (2018, July 5). Foodora dishes out punishment to injured riders in "oppressive" policy, ABC investigation reveals. *ABC*. Retrieved from https://www.abc.net.au/news/2018-07-06/foodora-delivery-riders-bite-back-hierarchy-oppressive-legal/9938962

Cheng, A.-S., & Fleischmann, K. R. (2010). Developing a meta-inventory of human values. In *Proceedings of the ASIST Annual Meeting, 2010, October 22-27, Pittsburgh, PA, USA* (Vol. 47). https://doi.org/10.1002/meet.14504701232

Cockton, G. (2020). *Worth-Focused Design, book 1: Balance, integration, and generosity*. San Rafael, CA: Morgan & Claypool.

Coeckelbergh, M. (2013). *Human being @ risk: Enhancement, technology, and the evaluation of vulnerability transformations*. Dordrecht: Springer. https://doi.org/10.1007/978-94-007-6025-7

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, *20*(1), 37–46.

Consoli, L. (2008). The intertwining of ethics and methodology in science and engineering: A virtue-ethical approach. *Interdisciplinary Science Reviews*, *33*(3), 234–243. https://doi.org/10.1179/174327908X366923

Cooper, A., Reimann, R., Cronin, D., & Noessel, C. (2014). *About face: The essentials of interaction design* (4th ed.). Indianapolis, In: John Wiley.

Cooper, R. G., & Edgett, S. J. (2010). Developing a product innovation and technology strategy for your business. *Research Technology Management*, *53*(3), 33–40. https://doi.org/10.1080/08956308.2010.11657629

Cosner, R. R., Hynds, E. J., Fusfeld, A. R., Loweth, C. V., Scouten, C., & Albright, R. (2007). Integrating roadmapping into technical planning. *Research Technology Management*, *50*(6), 31–48. https://doi.org/10.1080/08956308.2007.11657471

Cummings, M. L. (2006). Integrating ethics in design through the value-sensitive design approach. *Science and Engineering Ethics*, *12*(4), 701–715.

https://doi.org/10.1007/s11948-006-0065-0

Davis, J., & Nathan, L. P. (2015). Value Sensitive Design: Applications, adaptations, and critiques. In Jeroen van den Hoven, P. E. Vermaas, & I. van de Poel (Eds.), *Handbook of ethics, values, and technological design: Sources, theory, values and application domains* (pp. 11–40). Dordrecht: Springer. https://doi.org/10.1007/978-94-007-6970-0

Davis, R. A. (2001). Cognitive-behavioral model of pathological Internet use. *Computers in Human Behavior*, *17*(2), 187–195. https://doi.org/10.1016/S0747-5632(00)00041-8

de Alcantara, D. P., & Martens, M. L. (2019). Technology Roadmapping (TRM): A systematic review of the literature focusing on models. *Technological Forecasting and Social Change*, *138*, 127–138. https://doi.org/10.1016/j.techfore.2018.08.014

de Graaf, G. (2021). Value conflicts in academic teaching. *Teaching Public Administration*, *39*(1), 107–124. https://doi.org/10.1177/0144739420937755

de Graaf, G., & van der Wal, Z. (2008). On value differences experienced by sector switchers. *Administration and Society*, *40*(1), 79–103. https://doi.org/10.1177/0095399707311785

de La Rochefoucauld, F. (1664/2005). *Réflexions ou sentences et maximes morales.* Project Gutenberg.

Dean, D., Hender, J., Rodgers, T., & Santanen, E. (2006). Identifying quality, novel, and creative ideas: Constructs and scales for idea evaluation. *Journal of the Association for Information Systems*, *7*(10), 646–699. https://doi.org/10.17705/1jais.00106

Deneen, P. J. (2018). *Why liberalism failed*. Yale: University Press.

Dennis, A. R., Garfield, M. J., Adoption, G., Mingers, J., & Walsham, G. (2010). Toward ethical information systems: The contribution of discourse ethics. *MIS Quarterly*, *34*(4), 833–854.

Dissel, M. C., Phaal, R., Farrukh, C. J., & Probert, D. R. (2006). Value roadmapping: A structured approach for early stage technology investment decisions. In *Portland International Conference on Management of Engineering and Technology, PICMET 2006, Istanbul, Turkey, July 9-13* (pp. 1488–1495). https://doi.org/10.1109/PICMET.2006.296713

Dissel, M. C., Phaal, R., Farrukh, C. J., & Probert, D. R. (2009). Value roadmapping. *Research Technology Management*, *52*(6), 45–53. https://doi.org/10.1080/08956308.2009.11657599

Donaldson, T., & Preston, L. E. (1995). The stakeholder theory of the corporation: Concepts, evidence, and implications. *Academy of Management Review*, *20*(1), 65–91. https://doi.org/10.2307/258887

Doorn, N. (2012). Responsibility ascriptions in technology development and engineering: Three perspectives. *Science and Engineering Ethics*, *18*, 69–90. https://doi.org/10.1007/s11948-009-9189-3

Drašček, M., Rejc Buhovac, A., & Mesner Andolšek, D. (2020). Moral pragmatism as a bridge between duty, utility, and virtue in managers' ethical decision-making. *Journal of Business Ethics*, *172*, 803–819. https://doi.org/10.1007/s10551-020-04489-2

Drèze, J., & Stern, N. (1987). The theory of cost-benefit analysis. In A. J. Auerbach & M. Feldstein (Eds.), *Handbook of Public Economics* (Vol. 2, pp. 909–989). Amsterdam: North-Holland. https://doi.org/10.1016/S1573-4420(87)80009-5

Drummond, J., & Timmons, M. (2023). Moral phenomenology. In E. N. Zalta (Ed.), *Stanford Encyclopedia of Philosophy* (Fall 21). Retrieved from https://plato.stanford.edu/archives/fall2021/entries/moral-phenomenology/

Duff, A. S. (2016). Rating the revolution: Silicon Valley in normative perspective. *Information Communication & Society*, *19*(11), 1605–1621. https://doi.org/10.1080/1369118X.2016.1142594

Düwell, M. (2011). Menschenbilder und Anthropologie in der Bioethik [Image of man and bioethics]. *Ethik in Der Medizin*, *23*, 25–33. https://doi.org/10.1007/s00481-010-0109-5

Edison, H., Bin Ali, N., & Torkar, R. (2013). Towards innovation measurement in the software industry. *Journal of Systems and Software*, *86*, 1390–1407. https://doi.org/10.1016/j.jss.2013.01.013

Elhai, J. D., Levine, J. C., Dvorak, R. D., & Hall, B. J. (2016). Fear of missing out, need for touch, anxiety and depression are related to problematic smartphone use. *Computers in Human Behavior*, *63*, 509–516. https://doi.org/10.1016/j.chb.2016.05.079

Erez, M., & Nouri, R. (2010). Creativity: The influence of cultural, social, and work contexts. *Management and Organization Review*, *6*(3), 351–370. https://doi.org/10.1111/j.1740-8784.2010.00191.x

European Commission Directorate-General for Research and Innovation. (2013). *Options for strengthening responsible research and innovation: Report of the expert group on the state of art in Europe on responsible research and innovation*. Luxembourg. Retrieved from https://data.europa.eu/doi/10.2777/46253

Fahrenberg, J. (2007). *Menschenbilder: Psychologische, biologische interkulturelle und religiöse Ansichten [Concepts of man ("Menschenbilder", assumptions about human nature): Psychological, biological, cross-cultural & religious perspectives]*. Universität Freiburg: Institut für Psychologie. Retrieved from http://psydok.psycharchives.de/jspui/bitstream/20.500.11780/431/1/e_Buch_MENSCHENBILDER_J._Fahrenberg_2007_100807.pdf

Fenwick, D., Daim, T. U., & Gerdsri, N. (2009). Value Driven Technology Road Mapping (VTRM) process integrating decision making and marketing tools: Case of Internet security technologies. *Technological Forecasting and Social Change*, *76*(8), 1055–1077. https://doi.org/10.1016/j.techfore.2009.04.005

Flanagan, M., Howe, D. C., & Nissenbaum, H. (2005). Values at play: Design tradeoffs in socially-oriented game design. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI 2005)* (pp. 751–760). ACM. https://doi.org/10.1145/1054972.1055076

Flanagan, M., Howe, D. C., & Nissenbaum, H. (2008). Embodying values in technology: Theory and practice. In Jeroen van den Hoven & J. Weckert (Eds.), *Information Technology and Moral Philosophy* (pp. 322–353). Cambridge University Press.

Fleischmann, K. R., & Wallace, W. A. (2010). Value conflicts in computational modeling. *Computer*, *43*(7), 57–63.

Frankena, W. K. (1973). *Ethics* (2nd ed.). Englewood Cliffs, New Jersey: Prentice-Hall.

Frankfurt, H. G. (1988). Freedom of the will and the concept of a person. In M. F. Goodman (Ed.), *What is a person? Contemporary issues in biomedicine, ethics, and society* (pp. 127–144). Clifton, NJ: The Humana Press. https://doi.org/https://doi.org/10.1007/978-1-4612-3950-5

Franssen, M., Lokhorst, G.-J., & van de Poel, I. (2009). Philosophy of technology. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Fall 2015). Retrieved from https://plato.stanford.edu/archives/fall2015/entries/technology/

Frauenberger, C. (2019). Entanglement HCI: The next wave? *ACM Transactions on Computer-Human Interaction*, *27*(1), 1–27. https://doi.org/10.1145/3364998

Freeman, R. E., & Reed, D. L. (1983). Stockholders and stakeholders: A new perspective on corporate governance. *California Management Review*, *15*(3), 88–106.

Freudenreich, B., Lüdeke-Freund, F., & Schaltegger, S. (2020). A stakeholder theory perspective on business models: Value creation for sustainability. *Journal of Business Ethics*, *166*, 3–18. https://doi.org/10.1007/s10551-019-04112-z

Friedman, B. (1997). Introduction. In *Human values and the design of computer technology* (pp. 1–18). Stanford, CA & Cambridge, NY: CSLI Publications & Cambridge University Press.

Friedman, B., & Hendry, D. G. (2019). *Value Sensitive Design: Shaping technology with moral imagination*. Cambridge, MA: MIT Press.

Friedman, B., Hendry, D. G., & Borning, A. (2017). A survey of Value Sensitive Design methods. *Foundations and Trends® in Human–Computer Interaction*, *11*(2), 63–125. https://doi.org/10.1561/1100000015

Friedman, B., & Kahn, Jr., P. H. (2003). Human values, ethics, and design. In J. A. Jacko & A. Sears (Eds.), *The human-computer interaction handbook: Fundamentals, evolving technologies, and emerging applications* (pp. 1177–1201). Mahwah, N.J.: Lawrence Erlbaum Associates.

Friedman, B., Kahn Jr., P. H., & Borning, A. (2006). Value sensitive design and information systems. In P. Zhang & D. Galletta (Eds.), *Human-computer interaction and management information systems: Foundations* (pp. 348–372). Armonk, NY: M.E.Sharpe.

Friedman, B., Kahn, P. H., Borning, A., & Huldtgren, A. (2013). Value sensitive design and information systems. In N. Doorn, D. Schuurbiers, I. van de Poel, & M. E. Gorman (Eds.), *Early engagement and new technologies: Opening up the laboratory* (pp. 55–95). Dordrecht: Springer Science+Business Media.

Friese, S. (2018). ATLAS.ti 8 Windows User Manual. Retrieved from http://downloads.atlasti.com/docs/manual/atlasti_v8_manual_en.pdf

Fuchs, T. (2018). *Ecology of the brain: The phenomenology and biology of the embodied mind*. Oxford University Press.

Fuchs, T. (2020). Values as relational phenomena: A sketch of an enactive theory of value. In M. Mühling, D. A. Gilland, & Y. Förster (Eds.), *Perceiving truth and value: Interdisciplinary discussions on perception as the foundation of ethics* (pp. 23–42). Göttingen: Vandenhoeck & Ruprecht. https://doi.org/10.13109/9783666573200.23

Fukuyama, F. (2002). *Our posthuman future: Consequences of the biotechnology revolution*. New York: Farrar, Straus and Giroux.

Geissinger, A., Laurell, C., Öberg, C., Sandström, C., & Suseno, Y. (2022). The sharing economy and the transformation of work: Evidence from Foodora. *Personnel Review*, *51*(2), 584–602. https://doi.org/10.1108/PR-08-2019-0450

Gibson, J. J. (1979/1986). *The ecological approach to visual perception*. New York: Taylor & Francis. https://doi.org/https://doi.org/10.4324/9780203767764

Gimpel, H., & Schmied, F. (2019). Risks and side effects of digitalization: A multi-level taxonomy of the adverse effects of using digital technologies and media. In *27th European Conference on Information Systems (ECIS 2019), Stockholm & Uppsala, Sweden, June 8-14, 2019* (pp. 1–15). Retrieved from https://aisel.aisnet.org/ecis2019_rp/145

Gorgievski, M. J., Stephan, U., Laguna, M., & Moriano, J. A. (2018). Predicting entrepreneurial career intentions: Values and the Theory of Planned Behavior. *Journal of Career Assessment*, *26*(3), 457–475. https://doi.org/10.1177/1069072717714541

Greene, D., & Shilton, K. (2018). Platform privacies: Governance, collaboration, and the different meanings of "privacy" in iOS and Android development. *New Media & Society*, *20*(4), 1640–1657. https://doi.org/https://doi.org/10.1177/1461444817702397

Greene, J. D., Nystrom, L. E., Engell, A. D., Darley, J. M., & Cohen, J. D. (2004). The neural bases of cognitive conflict and control in moral judgment. *Neuron*, *44*, 389–400.

Grunwald, A. (2015). Technology assessment and design for values. In Jeroen van den Hoven, P. E. Vermaas, & I. van de Poel (Eds.), *Handbook of ethics, values, and technological design: Sources, theory, values and application domains* (pp. 67–86). Dordrecht: Springer Science+Business Media. https://doi.org/10.1007/978-94-007-6970-0_4

Grunwald, A. (2017). Responsible Research and Innovation (RRI): Limits to consequentialism and the need for hermeneutic assessment. In W. Hofkirchner & M. Burgin (Eds.), *The future information society: Social and technological problems* (pp. 139–152). Singapore: World Scientific.

Grunwald, A. (2020). The objects of technology assessment: Hermeneutic extension of consequentialist reasoning. *Journal of Responsible Innovation*, *7*(1), 96–112. https://doi.org/10.1080/23299460.2019.1647086

Guilford, J. P. (1966). Measurement and creativity. *Theory Into Practice*, *5*(4), 185–189. https://doi.org/10.1080/00405846609542023

Guilford, J. P. (1971). *The nature of human intelligence*. London: McGraw-Hill.

Habermas, J. (1993). *Justification and application: Remarks on discourse ethics*. Cambridge, MA & London: MIT Press.

Haidt, J. (2001). The emotional dog and its rational tail: A social intuitionist approach to moral judgment. *Psychological Review*, *108*(4), 814–834. https://doi.org/10.1037//0033-295X.108.4.814

Han, J., Forbes, H., & Schaefer, D. (2019). An exploration of the relations between functionality, aesthetics and creativity in design. In *Proceedings of the 22nd International Conference on Engineering Design (ICED19), Delft, The Netherlands, 5-8 August 2019* (pp. 259–268). https://doi.org/10.1017/dsi.2019.29

Haraway, D. J. (1991). A cyborg manifesto: Science, technology, and socialist-feminism in the late twentieth century. In Donna Haraway (Ed.), *Simians, cyborgs and women: The reinvention of nature* (pp. 149–181). New York: Routledge. https://doi.org/10.1080/08164649.1987.9961538

Harkrider, L. N., Thiel, C. E., Bagdasarov, Z., Mumford, M. D., Johnson, J. F., Connelly, S., & Devenport, L. D. (2012). Improving case-based ethics training with codes of conduct and forecasting content. *Ethics and Behavior*, *22*(4), 258–280.

https://doi.org/10.1080/10508422.2012.661311

Hartmann, N. (1932). *Ethics*. London: George Allen & Unwin.

Hauschildt, J., & Salomo, S. (2011). *Innovationsmanagement*. München: Franz Vahlen.

Helbing, D., Fanitabasi, F., Giannotti, F., Hänggli, R., Hausladen, C. I., van den Hoven, J., … Pournaras, E. (2021). Ethics of smart cities: Towards value-sensitive design and co-evolving city life. *Sustainability*, *13*(20), 1–25. https://doi.org/10.3390/su132011162

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly*, *28*(1), 75–105. https://doi.org/10.2307/25148625

Hodges, B. H., & Baron, R. M. (1994). Values as constraints on affordances. *Journal for the Theory of Social Behavior*, *22*(3), 263–294.

Hodges, B. H., & Rączaszek-Leonardi, J. (2022). Ecological values theory: Beyond conformity, goal-seeking, and rule-following in action and interaction 2. *Review of General Psychology*, *26*(1), 86–103. https://doi.org/10.1177/10892680211048174

Holden, J. (2020, January 30). Benefits of data protection regulation come at a price. *Irish Times*. Retrieved from https://www.irishtimes.com/business/innovation/benefits-of-data-protection-regulation-come-at-a-price-1.4145544

Hulstijn, J., & Burgemeestre, B. (2015). Design for the values of accountability and transparency. In Jeroen van den Hoven, P. E. Vermaas, & I. van de Poel (Eds.), *Handbook of ethics, values, and technological design: Sources, theory, values and application domains* (pp. 303–333). Dordrecht: Springer Science+Business Media. https://doi.org/10.1007/978-94-007-6970-0

Hume, D. 1777. (1777). *An enquiry concerning the principles of morals*. Urbana, Illinois: Project Gutenberg. Retrieved from https://www.gutenberg.org/ebooks/4320

Hursthouse, R., & Pettigrove, G. (2022). Virtue ethics. In E. N. Zalta & U. Nodelman (Eds.), *Stanford Encyclopedia of Philosophy* (Winter 22). Retrieved from https://plato.stanford.edu/archives/win2022/entries/ethics-virtue

IBM. (2018). *Everyday Ethics for Artificial Intelligence: A practical guide for designers & developers*. Retrieved from https://www.ibm.com/watson/assets/duo/pdf/everydayethics.pdf

IEEE Computer Society. (2021). IEEE 7000-2021 standard model process for addressing ethical concerns during system design. Piscataway: IEEE Computer Society.

Ihde, D. (1990). *Technology and the lifeworld: From garden to earth*. Bloomington and Indianapolis: Indiana University Press.

Ihde, D., & Malafouris, L. (2019). Homo faber revisited: Postphenomenology and material engagement theory. *Philosophy and Technology*, *32*(2), 195–214. https://doi.org/10.1007/s13347-018-0321-7

ISO. (2022). ISO/IEC/IEEE 24748-7000: Standard model process for addressing ethical concerns during system design — Systems and software engineering — Life cycle management — Part 7000. Piscataway: ISO/IEC JTC 1/SC 7 Software and systems engineering. Retrieved from https://www.iso.org/standard/84893.html

Ivanova, M., Bronowicka, J., Kocher, E., & Degner, A. (2018). *Foodora and Deliveroo: The app as a boss? Control and autonomy in app-based management: The case of food delivery riders*. *Working Paper Forschungsförderung*. Düsseldorf. Retrieved from https://nbn-resolving.de/urn:nbn:de:101:1-2019022610132332740779

Jacobs, N., & Huldtgren, A. (2021). Why value sensitive design needs ethical commitments. *Ethics and Information Technology*, *23*, 23–26. https://doi.org/10.1007/s10676-018-9467-3

Jeffrey, H., Sedgwick, J., & Robinson, C. (2013). Technology roadmaps: An evaluation of their success in the renewable energy sector. *Technological Forecasting and Social Change*, *80*(5), 1015–1027. https://doi.org/10.1016/j.techfore.2012.09.016

Jha, A. K., & Bose, I. (2016). Innovation research in information systems: A commentary on contemporary trends and issues. *Information and Management*, *53*(3), 297–306. https://doi.org/10.1016/j.im.2015.10.007

Jobin, A., Ienca, M., & Vayena, E. (2019). The global landscape for AI ethics guidelines. *Nature Machine Intelligence*, *1*, 389–399. https://doi.org/10.1038/s42256-019-0088-2

Johnson, D. G. (2015). Technology with no human responsibility? *Journal of Business Ethics*, *127*, 707–715. https://doi.org/10.1007/s10551-014-2180-1

Jolibert, A., & Baumgartner, G. (1997). Values, motivations, and personal goals: Revisited. *Psychology and Marketing*, *14*(7), 675–688. https://doi.org/10.1002/(SICI)1520-6793(199710)14:7<675::AID-MAR3>3.0.CO;2-D

Jonas, H. (1984). *The imperative of responsibility: In search of an ethics for the technological age*. Chicago & London: The University of Chicago Press.

Kagan, S. (2018). *Normative ethics*. New York, London: Routledge.

Kant, I. (1804/1981). *Grounding for the metaphysics of morals*. Indianapolis: Hackett Publishing Company.

Kant, I. (1785/2011). *Groundwork of the metaphysics of morals*. (M. Gregor & J. Timmermann, Eds.). Cambridge University Press.

Kappel, T. A. (2001). Perspectives on roadmaps: How organizations talk about the future. *Journal of Product Innovation Management*, *18*(1), 39–50. https://doi.org/10.1016/S0737-6782(00)00066-7

Kardefelt-Winther, D. (2014). A conceptual and methodological critique of internet addiction research: Towards a model of compensatory internet use. *Computers in Human Behavior*, *31*, 351–354. https://doi.org/10.1016/j.chb.2013.10.059

Kelly, E. (2011). *Material ethics of value: Max Scheler and Nicolai Hartmann*. Dordrecht: Springer.

Kerr, C., & Phaal, R. (2020). Technology roadmapping: Industrial roots, forgotten history and unknown origins. *Technological Forecasting and Social Change*, *155*, 119967. https://doi.org/10.1016/j.techfore.2020.119967

Kettner, M. (2017). Between enthusiasm and overkill: Assessing Michael Porter's conceptual management frame of creating shared value. In J. Wieland (Ed.), *Creating shared value: Concepts, experience, criticism* (pp. 153–168). Springer Cham. https://doi.org/10.1007/978-3-319-48802-8_9

Kheirandish, S., Funk, M., Wensveen, S., Verkerk, M., & Rauterberg, M. (2020). A comprehensive value framework for design. *Technology in Society*, *62*, 101302. https://doi.org/10.1016/j.techsoc.2020.101302

Kibert, C. J., Monroe, M., Peterson, A. L., Plate, R. R., & Thiele, L. P. (2012). *Working toward sustainability: Ethical decision-making in a technological world*. John Wiley & Sons.

Kluckhohn, C. (1962). Values and value-orientations in the theory of action: An exploration in definition and classification. In T. Parsons & E. A. Shils (Eds.), *Toward a general theory of action* (pp. 388–433). Cambridge, MA: Harvard University Press.

Komando, K. (2015, December 22). Why you should say "goodbye" to Hello Barbie. *CNBC*. Retrieved from https://www.cnbc.com/2015/12/22/why-you-should-say-goodbye-to-hello-barbie.html

Krippendorff, K., Mathet, Y., Bouvry, S., & Widlöcher, A. (2016). On the reliability of unitizing textual continua: Further developments. *Quality & Quantity*, *50*, 2347–2364. https://doi.org/10.1007/s11135-015-0266-1

Krobath, H. T. (2009). *Werte: Ein Streifzug durch Philosophie und Wissenschaft*. Würzburg: Königshausen & Neumann.

Kroes, P., & van de Poel, I. (2015). Design for values and the definition, specification, and operationalization of values. In J. van den Hoven, P. Vermaas, & I. van de Poel (Eds.), *Handbook of ethics, values, and technological design: Sources, theory, values and application domains* (pp. 151–178). Dordrecht: Springer. https://doi.org/10.1007/978-94-

007-6970-0

Kudina, O., & Verbeek, P. P. (2019). Ethics from within: Google Glass, the Collingridge Dilemma, and the mediated value of privacy. *Science Technology and Human Values*, *44*(2), 291–314. https://doi.org/10.1177/0162243918793711

Kuhn, S., & Muller, M. J. (1993). Participatory design. *Communications of the ACM*, *36*(4), 24–28. https://doi.org/10.1145/153571.255960

Kuss, D. J., Griffiths, M. D., & Binder, J. F. (2013). Internet addiction in students: Prevalence and risk factors. *Computers in Human Behavior*, *29*, 959–966. https://doi.org/10.1016/j.chb.2012.12.024

Lago, P., Koçak, S. A., Crnkovic, I., & Penzenstadler, B. (2015). Framing sustainability as a property of software quality. *Communications of the ACM*, *58*(10), 70–78. https://doi.org/10.1145/2714560

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, *33*(1), 159–174. https://doi.org/10.2307/2529310

Langheinrich, M., & Lahlou, S. (2003). A troubadour approach to privacy. *Ambient Agoras Report*, *15.3.1.*, 2–29.

Latta, G. F., & Dugan, M. (2019). Comparing ethical decision-making among undergraduates: The impact of institutional values. *Journal of Higher Education Theory and Practice*, *19*(2), 56–77. https://doi.org/10.33423/jhetp.v19i2.1443

Le Dantec, C. A., Poole, E. S., & Wyche, S. P. (2009). Values as lived experience: Evolving Value Sensitive Design in support of value discovery. *Proceedings of the 27th International Conference on Human Factors in Computing Systems (CHI '09)*, 1141–1150. https://doi.org/10.1145/1518701.1518875

Lee, S., Jang, K. J., Lee, M. H., & Shin, S. R. (2021). Roadmapping in the era of uncertainty: How to integrate data-driven methods with expert insights. *Foresight and STI Governance*, *15*(2), 39–51. https://doi.org/10.17323/2500-2597.2021.2.39.51

Lepp, A., Li, J., Barkley, J. E., & Salehi-Esfahani, S. (2015). Exploring the relationships between college students' cell phone use, personality and leisure. *Computers in Human Behavior*, *43*, 210–219. https://doi.org/10.1016/j.chb.2014.11.006

Li, J., Lepp, A., & Barkley, J. E. (2015). Locus of control and cell phone use: Implications for sleep quality, academic performance, and subjective well-being. *Computers in Human Behavior*, *52*, 450–452. https://doi.org/10.1016/j.chb.2015.06.021

Li, X., Hess, T. J., & Valacich, J. S. (2008). Why do we trust new technology? A study of initial trust formation with organizational information systems. *Journal of Strategic*

Information Systems, 17(1), 39-71. https://doi.org/10.1016/j.jsis.2008.01.001

Linden, A., & Fenn, J. (2003). *Understanding Gartner's hype cycles*. *Strategic analysis report Nº R-20-1971*. Retrieved from http://www.ask-force.org/web/Discourse/Linden-HypeCycle-2003.pdf

Lombard, M., Snyder-Duch, J., & Bracken, C. C. (2002). Content analysis in mass communication: Assessment and reporting of intercoder reliability. *Human Communication Research*, *28*(4), 587–604. https://doi.org/10.1093/hcr/28.4.587

Lusoli, W., & Miltgen, C. (2009). *Young people and emerging digital services: An exploratory survey on motivations, perceptions and acceptance of risks*. (W. Lusoli, R. Compañó, & I. Maghiros, Eds.), *JRC Scientific and Technical Reports*. Luxembourg: Office for Official Publications of the European Communities. Retrieved from https://joinup.ec.europa.eu/sites/default/files/document/2014-12/Young People and Emerging Digital Services - An Explanatory Survey of Motivations%2C Perceptions and Acceptance of Risks.pdf

MacIntyre, A. (1981/2007). *After virtue: A study in moral theory* (3rd ed.). Notre Dame, Indiana: University of Notre Dame Press. https://doi.org/10.4324/9781912281954

Malafouris, L. (2014). Creative thinging. *Pragmatics & Cognition*, *22*(1), 140–158. https://doi.org/10.1075/pc.22.1.08mal

Manders-Huits, N. (2011). What values in design? The challenge of incorporating moral values into design. *Science and Engineering Ethics*, *17*(2), 271–287. https://doi.org/10.1007/s11948-010-9198-2

Martin, K., Shilton, K., & Smith, J. (2019). Business and the ethical implications of technology: Introduction to the symposium. *Journal of Business Ethics*, *160*(2), 307–317. https://doi.org/10.1007/s10551-019-04213-9

Martins, E. C., & Terblanche, F. (2003). Building organisational culture that stimulates creativity and innovation. *European Journal of Innovation Management*, *6*(1), 64–74. https://doi.org/10.1108/14601060310456337

Maslow, A. H. (1943). A theory of human motivation. *Psychological Review*, *50*(4), 370–396. https://doi.org/10.1037/h0054346

Mayring, P. (2014). Qualitative content analysis: Theoretical foundation, basic procedures and software solution. Retrieved from http://nbn-resolving.de/urn:nbn:de:0168-ssoar-395173

Meijer, A., & De Jong, J. (2020). Managing value conflicts in public innovation: Ostrich, chameleon, and dolphin strategies. *International Journal of Public Administration*, *43*(11), 977–988. https://doi.org/10.1080/01900692.2019.1664568

Messick, D. M., & Bazerman, M. H. (2001). Ethical leadership and the psychology of decision making. *Research in Ethical Issues in Organizations*, *3*, 213–238. https://doi.org/10.1016/s1529-2096(01)03014-0

Mill, J. S. (1879/2009). *Utilitarianism*. The Floating Press.

Miller, B. (2021). Is technology value-neutral? *Science, Technology, & Human Values*, *46*(1), 53–80. https://doi.org/10.1177/0162243919900965

Miller, J. K., Friedman, B., Jancke, G., & Gill, B. (2007). Value tensions in design: The value sensitive design, development, and appropriation of a corporation's groupware system. *GROUP'07 Proceedings of the 2007 International ACM Conference on Supporting Group Work*, 281–290. https://doi.org/10.1145/1316624.1316668

Mingers, J. (2001). Combining IS research methods: Towards a pluralist methodology. *Information Systems Research*, *12*(3), 240–259. https://doi.org/10.1287/isre.12.3.240.9709

Mittelstadt, B. (2019). Principles alone cannot guarantee ethical AI. *Nature Machine Intelligence*, *1*, 501–507. https://doi.org/10.1038/s42256-019-0114-4

Monbiot, G. (2017). *Out of the wreckage: A new politics for an age of crisis*. London & New York: Verso.

Mondal, M., Silva, L. A., & Benevenuto, F. (2017). A measurement study of hate speech in social media. In *Proceedings of the 28th ACM Conference on Hypertext and Social Media* (pp. 85–94). https://doi.org/10.1145/3078714.3078723

Moor, J. H. (1999). Just consequentialism and computing. *Ethics and Information Technology*, *1*, 65–69. https://doi.org/10.1023/A:1010078828842

Moor, J. H. (2005). Why we need better ethics for emerging technologies. *Ethics and Information Technology*, *7*, 111–119. https://doi.org/10.1007/s10676-006-0008-0

Munch, J., Trieflinger, S., & Lang, D. (2019). Product roadmap - From vision to reality: A systematic literature review. *Proceedings of the IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC), Valbonne Sophia-Antipolis, France*. https://doi.org/10.1109/ICE.2019.8792654

Münch, J., Trieflinger, S., & Lang, D. (2018). Why feature-based roadmaps fail in rapidly changing markets: A qualitaitve survey. In *Proceedings of the International Workshop on Software-intensive Business: Start-ups, Ecosystems and Platforms (SiBW 2018)* (pp. 203–218).

Myers, M. D., & Venable, J. R. (2014). A set of ethical principles for design science research in information systems. *Information and Management*, *51*, 801–809.

https://doi.org/10.1016/j.im.2014.01.002

Nagel, T. (1989). *The view from nowhere*. New York & Oxford: Oxford University Press.

Ngai, E. W. T., Tao, S. S. C., & Moon, K. K. L. (2015). Social media research: Theories, constructs, and conceptual frameworks. *International Journal of Information Management*, *35*, 33–44. https://doi.org/10.1016/j.ijinfomgt.2014.09.004

Nicolescu, R., Huth, M., Radanliev, P., & De Roure, D. (2018). Mapping the values of IoT. *Journal of Information Technology*, *33*(4), 345–360. https://doi.org/10.1057/s41265-018-0054-1

Nissenbaum, H. (2005). Values in technical design. In C. Mitcham (Ed.), *Encyclopedia of sciency, technology, and ethics* (pp. 65–69). Detroit, MI: Macmillan Reference.

Nissenbaum, H. (2009). *Privacy in context: Technology, policy, and the integrity of social life*. Stanford, CA: Stanford Law Books.

Nonaka, I., & Takeuchi, H. (2011). The wise leader (2011, May). *Harvard Business Review*, 58–67.

Norman, D. A. (2013). *The design of everyday things* (rev. & exp). New York: Basic Books.

O'Sullivan, E., Phaal, R., & Featherston, C. (2021). Agile roadmapping: An adaptive approach to technology foresight. *Foresight and STI Governance*, *15*(2), 65–81. https://doi.org/10.17323/2500-2597.2021.2.65.81

Offermann, P., Blom, S., Bub, U., & Levina, O. (2010). Proposal for components of method design theories: Increasing the utility of method design artefacts. *Business & Information Systems Engineering*, *5*, 295–304. https://doi.org/10.1007/s12599-010-0120-x

Osburn, H. K., & Mumford, M. D. (2006). Creativity and planning: Training interventions to develop creative problem-solving skills. *Creativity Research Journal*, *18*(2), 173–190. https://doi.org/10.1207/s15326934crj1802_4

Peeters, G. (1971). The positive-negative asymmetry: On cognitive consistency and positivity bias. *European Journal of Social Psychology*, *1*(4), 455–474. https://doi.org/10.1002/ejsp.2420010405

Peffers, K., Tuunanen, T., Rothenberger, M. A., & Chatterjee, S. (2007). A design science research methodology for information systems research. *Journal of Management Information Systems*, *24*(3), 45–77. https://doi.org/10.2753/MIS0742-1222240302

Penzenstadler, B., & Femmer, H. (2013). A generic model for sustainability with process- and product-specific instances. *Proceedings of the 2013 Workshop on Green in Software Engineering, Green by Software Engineering (GIBSE '13)*.

https://doi.org/10.1145/2451605.2451609

Pereira, R., & Baranauskas, M. C. C. (2015). A value-oriented and culturally informed approach to the design of interactive systems. *International Journal of Human Computer Studies*, *80*, 66–82. https://doi.org/10.1016/j.ijhcs.2015.04.001

Pew Research Center. (2014). *Public perceptions of privacy and security in the post-Snowden era*. https://doi.org/202.419.4372

Phaal, R., Farrukh, C. J. P., & Probert, D. R. (2004). Technology roadmapping: A planning framework for evolution and revolution. *Technological Forecasting and Social Change*, *71*, 5–26. https://doi.org/10.1016/S0040-1625(03)00072-6

Phaal, R., & Muller, G. (2009). An architectural framework for roadmapping: Towards visual strategy. *Technological Forecasting and Social Change*, *76*(1), 39–49. https://doi.org/10.1016/j.techfore.2008.03.018

Pham, T., Pham, D. K., Pham, A. T., Fox, M., Rothstein, L., Weiner, M., … Rijhsinghani, K. (2013). *From business strategy to information technology roadmap: A practical guide for executives and board members*. New York: Productivity Press. https://doi.org/https://doi.org/10.4324/9781315373195

Pommeranz, A., Detweiler, C., Wiggers, P., & Jonker, C. (2012). Elicitation of situated values: Need for tools to help stakeholders and designers to reflect and communicate. *Ethics and Information Technology*, *14*, 285–303. https://doi.org/10.1007/s10676-011-9282-6

Porter, M. E., & Kramer, M. R. (2011). Creating shared value. *Harvard Business Review*, *Jan-Feb*, 1–17.

Puccio, G. J., & Cabra, J. F. (2012). Idea generation and idea evaluation: Cognitive skills and deliberate practices. In *Handbook of Organizational Creativity* (pp. 189–215). Elsevier Inc. https://doi.org/10.1016/B978-0-12-374714-3.00009-4

Raworth, K. (2017). *Doughnut economics: Seven ways to think like 21st-century economist*. London: Random House Business.

Rector, K., Milne, L., Ladner, R. E., Friedman, B., & Kientz, J. A. (2015). Exploring the opportunities and challenges with exercise technologies for people who are blind or low-vision. *ASSETS 2015 - Proceedings of the 17th International ACM SIGACCESS Conference on Computers and Accessibility*, 203–214. https://doi.org/10.1145/2700648.2809846

Reid, G. G., & Boyer, W. (2013). Social network sites and young adolescent identity development. *Childhood Education*, *89*(4), 243–253. https://doi.org/10.1080/00094056.2013.815554

Reijers, W. (2018). Bringing virtue to "Value" Sensitive Design: A novel method for practising ethics in R&I using virtue ethics. *Orbit*.

Reijers, W., & Gordijn, B. (2019). Moving from value sensitive design to virtuous practice design. *Journal of Information, Communication and Ethics in Society*, *17*(2), 196–209. https://doi.org/10.1108/JICES-10-2018-0080

Rhodes, M. (1961). An analysis of creativity. *Phi Delta Kappan*, *42*(7), 305–310.

Roeser, S. (2012). Emotional engineers: Toward morally responsible design. *Science and Engineering Ethics*, *18*(1), 103–115. https://doi.org/10.1007/s11948-010-9236-0

Rogers, E. M. (1983). *Diffusion of innovations*. *An Integrated Approach to Communication Theory and Research* (3rd ed.). New York: Free Press. https://doi.org/10.4324/9780203710753-35

Rogers, E. M., & Shoemaker, F. F. (1971). *Communication of innovations: A cross-cultural approach*. New York: The Free Press.

Rokeach, M. (1973). *The nature of human values*. New York: Free Press.

Rose, J., Jones, M., & Furneaux, B. (2016). An integrated model of innovation drivers for smaller software firms. *Information and Management*, *53*(3), 307–323. https://doi.org/10.1016/j.im.2015.10.005

Ross, W. D. (1930). *The right and the good*. Oxford: Oxford University Press.

Rubin, J., & Chisnell, D. (2008). *Handbook of usability testing: How to plan, design, and conduct effective tests* (2nd ed.). Indianapolis, IN: Wiley Publishing.

Runco, M. A., & Jaeger, G. J. (2012). The standard definition of creativity. *Creativity Research Journal*, *24*(1), 92–96.

Russ, T. (2019). Is there an ethical obligation to act sustainably? In *Sustainability and design ethics* (2nd ed., pp. 49–71). Boca Raton: CRC Press. https://doi.org/10.1201/9781439808559

Salehan, M., & Negahban, A. (2013). Social networking on smartphones: When mobile phones become addictive. *Computers in Human Behavior*, *29*(6), 2632–2639. https://doi.org/10.1016/j.chb.2013.07.003

Scanlon, T. M. (1998). *What we owe to each other*. Cambridge, MA & London: Harvard University Press.

Scheler, M. (1913-1916/1973). *Formalism in ethics and non-formal ethics of values: A new attempt toward the foundation of an ethical personalism*. (M. S. Frings & R. L. Funk, Eds.). Evanston, Ill: Northwestern University Press.

Schniederjans, M. J., Hamaker, J. L., & Schniederjans, A. M. (2010). *Information technology investment: Decision-making methodology* (2nd ed.). New Jersey: World Scientific.

Schroeder, M. (2023). Value theory. In E. N. Zalta (Ed.), *Stanford Encyclopedia of Philosophy* (Fall 21). Retrieved from https://plato.stanford.edu/archives/fall2021/entries/value-theory/

Schwartz, S. H. (1992). Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries. *Advances in Experimental Social Psychology*, *25*, 1–65. https://doi.org/10.1016/S0065-2601(08)60281-6

Schwartz, S. H. (1994). Are there universal aspects in the structure and contents of human values? *Journal of Social Issues*, *50*(4), 19–45. https://doi.org/10.1111/j.1540-4560.1994.tb01196.x

Sharon, T. (2014). *Human nature in an age of biotechnology: The case for mediated posthumanism*. Dordrecht: Springer Science+Business Media. https://doi.org/10.1007/978-94-007-7554-1

Shasha, S., Mahmoud, M., Mannan, M., & Youssef, A. (2019). Playing with danger: A taxonomy and evaluation of threats to smart toys. *IEEE Internet of Things Journal*, *6*(2), 2986–3002. https://doi.org/10.1109/JIOT.2018.2877749

Shearman, R. (1990). The meaning and ethics of sustainability. *Environmental Management*, *14*(1), 1–8. https://doi.org/10.1007/BF02394014

Shiell, A., Hawe, P., & Seymour, J. (1997). Values and preferences are not necessarily the same. *Health Economics*, *6*, 515–518. https://doi.org/10.1002/(SICI)1099-1050(199709)6:5<515::AID-HEC292>3.0.CO;2-N

Shilton, K. (2013). Values levers: Building ethics into design. *Science, Technology, & Human Values*, *38*(3), 374–397. https://doi.org/10.1177/0162243912436985

Shilton, K. (2018). Values and ethics in Human-Computer Interaction. *Foundations and Trends in Human-Computer Interaction*, *12*(2), 107–171. https://doi.org/10.1561/1100000073

Specht, G., Beckmann, C., & Amelingmeyer, J. (2002). *F&E-Management: Kompetenz im Innovationsmanagement*. Stuttgart: Schäffer-Poeschel.

Spiekermann-Hoff, S., Winkler, T., & Bednar, K. (2019). *A telemedicine case study for the early phases of value based engineering* (Working Paper Series/Institute for IS & Society No. 001_vs 1). *Working Paper Series/Institute for IS & Society*. Vienna: WU Vienna University of Economics and Business. Retrieved from https://epub.wu.ac.at/7119/

Spiekermann, S. (2016). *Ethical IT innovation: A value-based system design approach*. Boca

Raton: CRC Press.

Spiekermann, S. (2023). Value-based engineering: A guide to building ethical technology for humanity. Berlin: De Gruyter.

Spiekermann, S., Korunovska, J., & Langheinrich, M. (2018). Inside the organization: Why privacy and security engineering is a challenge for engineers. *Proceedings of the IEEE*, *107*(3), 600–615. https://doi.org/10.1109/JPROC.2018.2866769

Spiekermann, S., Krasnova, H., Hinz, O., Baumann, A., Benlian, A., Gimpel, H., … Trenz, M. (2022). Values and ethics in information systems: A state-of-the-art analysis and avenues for future research. *Business and Information Systems Engineering*, *64*(2), 247–264. https://doi.org/10.1007/s12599-021-00734-8

Spiekermann, S., & Winkler, T. (2020). Value-based Engineering for Ethics by Design. *ArXiv*, *2004.13676*. Retrieved from https://arxiv.org/abs/2004.13676

Stahl, B. C., Eden, G., Jirotka, M., & Coeckelbergh, M. (2014). From computer ethics to responsible research and innovation in ICT: The transition of reference discourses informing ethics-related research in information systems. *Information and Management*, *51*(6), 810–818. https://doi.org/10.1016/j.im.2014.01.001

Steen, M., & van de Poel, I. (2012). Making values explicit during the design process. *IEEE Technology and Society Magazine*, *31*(4), 63–72. https://doi.org/10.1109/MTS.2012.2225671

Stiegler, B. (2019). *The age of disruption: technology and madness in computational capitalism*. Cambridge: Polity Press.

Stolterman, E. (2008). The nature of design practice and implications for interaction design research. *International Journal of Design*, *2*(1), 55–65.

Storey, C., Cankurtaran, P., Papastathopoulou, P., & Hultink, E. J. (2016). Success factors for service innovation: A meta-analysis. *Journal of Product Innovation Management*, *33*(5), 527–548. https://doi.org/10.1111/jpim.12307

Szekely, I. (2011). What do IT professionals think about surveillance? In C. Fuchs, K. Boersma, A. Albrechtslund, & M. Sandoval (Eds.), *Internet and surveillance: The challenges of Web 2.0 and social media* (pp. 198–219). New York: Routledge.

Taebi, B., Correljé, A., Cuppen, E., Dignum, M., & Pesch, U. (2014). Responsible innovation as an endorsement of public values: The need for interdisciplinary research. *Journal of Responsible Innovation*, *1*(1), 118–124. https://doi.org/10.1080/23299460.2014.882072

The Economist. (n.d.). Oh, Mr. Porter. Retrieved from https://www.economist.com/business/2011/03/10/oh-mr-porter

The European Parliament and the Council of the European Union. (2016). Regulation (EU) 2916/679 (General Data Protection Regulation). *Official Journal of the European Union*, *59*, 1–88. Retrieved from http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32016R0679&from=EN

Thys, E., Sabbe, B., & De Hert, M. (2014). The assessment of creativity in creativity/psychopathology research: A systematic review. *Cognitive Neuropsychiatry*, *19*(4), 359–377. https://doi.org/10.1080/13546805.2013.877384

Timmermans, J., Zhao, Y., & van den Hoven, J. (2011). Ethics and nanopharmacy: Value sensitive design of new drugs. *NanoEthics*, *5*(3), 269–283. https://doi.org/10.1007/s11569-011-0135-x

TNS Opinion & Social. (2015). *Special Eurobarometer 431: Data protection*. European Union. https://doi.org/10.2838/552336

Tomasello, M. (2014). *A natural history of human thinking*. Cambridge, MA & London: Harvard University Press.

Turulski, A.-S. (2022). Statistiken zur Smartphone-Nutzung in Österreich [Statistics on smartphone use in Austria]. *Statista*. Retrieved from https://de.statista.com/themen/3654/smartphone-nutzung-in-oesterreich/#dossierKeyfigures

Twenge, J. M., Martin, G. N., & Campbell, W. K. (2018). Decreases in psychological well-being among American adolescents after 2012 and links to screen time during the rise of smartphone technology. *Emotion*. https://doi.org/10.1037/emo0000403

Umbrello, S. (2018). The moral psychology of value sensitive design: The methodological issues of moral intuitions for responsible innovation. *Journal of Responsible Innovation*, *5*(2), 186–200. https://doi.org/10.1080/23299460.2018.1457401

Umbrello, S. (2020a). Combinatory and complementary practices of values and virtues in design: A reply to Reijers and Gordijn. *Filosofia*, (65), 107–121. https://doi.org/10.13135/2704-8195/5236

Umbrello, S. (2020b). Imaginative value sensitive design: Using moral imagination theory to inform responsible technology design. *Science and Engineering Ethics*, *26*, 575–595. https://doi.org/10.1007/s11948-019-00104-4

Umbrello, S., & van de Poel, I. (2021). Mapping value sensitive design onto AI for social good principles. *AI and Ethics*, *1*(3), 283–296. https://doi.org/10.1007/s43681-021-00038-3

Unger, M., Binder, D., Dibiasi, A., Engleder, J., Schubert, N., Terzieva, B., … Zucha, V. (2020). *Studierenden-Sozialerhebung 2019 Kernbericht [Student Social Survey 2019 Core Report]*. Vienna.

United Nations. (n.d.). The 17 goals. Retrieved March 27, 2023, from https://sdgs.un.org/goals

Vallor, S. (2012). Flourishing on facebook: Virtue friendship & new social media. *Ethics and Information Technology*, *14*(3), 185–199.

Vallor, S. (2016). *Technology and the virtues: A philosophical guide to a future worth wanting*. New York: Oxford University Press. https://doi.org/10.1093/acprof:oso/9780190498511.003.0001

van de Kaa, G., Rezaei, J., Taebi, B., van de Poel, I., & Kizhakenath, A. (2020). How to weigh values in Value Sensitive Design: A Best Worst Method approach for the case of smart metering. *Science and Engineering Ethics*, *26*(1), 475–494. https://doi.org/10.1007/s11948-019-00105-3

van de Poel, I. (2009). Values in engineering design. In A. Meijers (Ed.), *Handbook of the philosophy of science. Volume 9: Philosophy of technology and engineering sciences* (Vol. 9, pp. 973–1006). Amsterdam: Elsevier B.V. https://doi.org/10.1016/B978-0-444-51667-1.50040-9

van de Poel, I. (2015). Conflicting values in Design for Values. In J. van den Hoven, P. Vermaas, & I. van de Poel (Eds.), *Handbook of ethics, values, and technological design: Sources, theory, values and application domains* (pp. 89–115). Dordrecht: Springer. https://doi.org/10.1007/978-94-007-6970-0

van de Poel, I., & Kroes, P. (2014). Can technology embody values? In P. Kroes & P.-P. Verbeek (Eds.), *The moral status of technical artifacts* (pp. 103–124). Dordrecht: Springer. https://doi.org/10.1007/978-94-007-7914-3_7

van den Hoven, Jeroen. (2017). Ethics for the digital age: Where are the moral specs? In *Informatics in the future: Proceedings of the 11th European Computer Science Summit (ECSS 2015), Vienna, October 2015* (pp. 65–67). Cham: Springer Nature. https://doi.org/10.1007/978-3-319-55735-9

van den Hoven, Jeroen, Lokhorst, G. J., & van de Poel, I. (2012). Engineering and the problem of moral overload. *Science and Engineering Ethics*, *18*, 143–155. https://doi.org/10.1007/s11948-011-9277-z

van den Hoven, Jeroen, Vermaas, P. E., & van de Poel, I. (2015a). Design for values: An introduction. In Jeroen van den Hoven, P. E. Vermaas, & I. van de Poel (Eds.), *Handbook of ethics, values, and technological design: Sources, theory, values and application domains* (pp. 1–7). Dordrecht: Springer. https://doi.org/10.1007/978-94-007-6970-0_40

van den Hoven, Jeroen, Vermaas, P. E., & van de Poel, I. (Eds.). (2015b). *Handbook of ethics, values, and technological design: Sources, theory, values and application domains*. Dordrecht: Springer. https://doi.org/10.1007/978-94-007-6970-0 van Staveren, I. (2007). Beyond utilitarianism and deontology: Ethics in economics. *Review of Political Economy*, *19*(1), 21–35. https://doi.org/10.1080/09538250601080776

van Wynsberghe, A. (2013). Designing robots for care: Care centered Value-Sensitive Design. *Science and Engineering Ethics*, *19*(2), 407–433. https://doi.org/10.1007/s11948-011-9343-6

van Wynsberghe, A. (2021). Sustainable AI: AI for sustainability and the sustainability of AI. *AI and Ethics*, *1*(3), 213–218. https://doi.org/10.1007/s43681-021-00043-6

Velden, M. van der. (2018). ICT and sustainability: Looking beyond the anthropocene. In D. Kreps, C. Ess, L. Leenen, & K. Kimppa (Eds.), *This changes everything - ICT and climate change: What can we do?* (pp. 166–180). Cham: Springer Nature. https://doi.org/10.1007/978-319-99605-9_12

Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer acceptance and use of information technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Quarterly*, *36*(1), 157–178. https://doi.org/10.1111/j.1540-4560.1981.tb02627.x

Verbeek, P.-P. (2005). *What things do: Philosophical reflections on technology, agency, and design*. Pennsylvania: The Pennsylvania State University Press. https://doi.org/10.1017/CBO9781107415324.004

Verbeek, P.-P. (2006). Materializing morality: Design ethics and technological mediation. *Science, Technology, & Human Values*, *31*(3), 361–380. https://doi.org/10.2307/j.ctvqsdwxv.13

Verizon. (2017). *Data breach investigations report*. Retrieved from http://www.verizonenterprise.com/DBIR/2014/insider/?utm_source=earlyaccess&utm_medium=redirect&utm_campaign=DBIR

Verplanken, B., & Holland, R. W. (2002). Motivated decision making: Effects of activation and self-centrality of values on choices and behavior. *Journal of Personality and Social Psychology*, *82*(3), 434–447. https://doi.org/10.1037/0022-3514.82.3.434

Vinayavekhin, S., Phaal, R., Thanamaitreejit, T., & Asatani, K. (2021). Emerging trends in roadmapping research: A bibliometric literature review. *Technology Analysis and Strategic Management*, 1–15. https://doi.org/10.1080/09537325.2021.1979210

Wallach, W., & Vallor, S. (2020). Moral machines: From value alignment to embodied virtue. In S. M. Liao (Ed.), *Ethics of Artificial Intelligence* (pp. 383–412). Oxford University Press. https://doi.org/10.1093/oso/9780190905033.003.0014

Wang, K., & Nickerson, J. V. (2017). A literature review on individual creativity support systems. *Computers in Human Behavior*, *74*, 139–151. https://doi.org/10.1016/j.chb.2017.04.035

Winkler, T., & Spiekermann, S. (2019). Human values as the basis for sustainable information system design. *IEEE Technology and Society Magazine*, *38*(3), 34–43. https://doi.org/10.1109/MTS.2019.2930268

Winkler, T., & Spiekermann, S. (2021). Twenty years of value sensitive design: A review of methodological practices in VSD projects. *Ethics and Information Technology*, *23*, 17–21. https://doi.org/10.1007/s10676-018-9476-2

World Commission on Environment and Development (WCED). (1987). *Our common future*. New York: Oxford University Press.

Xiao, X., Califf, C. B., Sarker, S., & Sarker, S. (2013). ICT innovation in emerging economies: A review of the existing literature and a framework for future research. *Journal of Information Technology*, *28*(4), 264–278. https://doi.org/10.1057/jit.2013.20

Yao, M. Z., & Zhong, Z. (2014). Loneliness, social contacts and Internet addiction: A cross-lagged panel study. *Computers in Human Behavior*, *30*, 164–170. https://doi.org/10.1016/j.chb.2013.08.007

Yun, H., Lee, G., & Kim, D. J. (2019). A chronological review of empirical research on personal information privacy concerns: An analysis of contexts and research constructs. *Information and Management*, *56*(4), 570–601. https://doi.org/10.1016/j.im.2018.10.001

Appendices

Appendix A Author Publications

Table A1. List of relevant publications by the author

#	Publication	Type [Status]	Basis for Chapter
[1]	Bednar, K., & Spiekermann, S. (2018). Aware but not in control: A qualitative value analysis of the effects of new technologies. In D. Kreps, C. Ess, L. Leenen, & K. Kimppa (Eds.), *This changes everything - ICT and climate change: What can we do? Proceedings of the 13th IFIP TC 9 International Conference on Human Choice and Computers, HCC13 2018, Poznan, Poland, September 19–2* (pp. 202–218). Cham: Springer. https://doi.org/10.1007/978-3-319-99605-9	Conference proceedings [published]	1.1
[2]	Bednar, K., Spiekermann, S., & Langheinrich, M. (2019). Engineering Privacy by Design: Are engineers ready to live up to the challenge? *The Information Society*, *35*(3), 122–142. https://doi.org/10.1080/01972243.2019.1583296	Journal article [published]	1.1
[3]	Bednar, K., & Spiekermann, S. (2020). The power to design: Exploring utilitarianism, deontology, and virtue ethics in three technology case studies. In A. M. L. P. Jorge Pelegrín-Borondo, Mario Arias-Oliva, Kiyoshi Murata (Ed.), *Paradigm Shifts in ICT Ethics: Proceedings of the ETHICOMP 2020* (pp. 396–399). Logroño: Universidad de La Rioja.	Conference proceedings [published]	4
[4]	Bednar, K., & Spiekermann, S. (2022). Eliciting values for technology design with moral philosophy: An empirical exploration of effects and shortcomings. *Science, Technology, & Human Values (OnlineFirst), 1-35.* https://doi.org/10.1177/01622439221122595	Journal article [published]	4.1
[5]	Bednar, K., & Spiekermann, S. [Latest decision: "Accept (with minor revisions)", March 10th, 2023]. The power of ethics: Uncovering technology risks and positive value potentials in the innovation process. *Business & Information Systems Engineering*.	Journal article [under review]	4.2
[6]	Bednar, K. (2020). Exploring human nature in a technology-driven society. In D. Kreps, T. Komukai, T. V. Gopal, & K. Ishii (Eds.), *Human-centric computing in a data-driven society: Proceedings of the 14th IFIP TC 9 International Conference on Human Choice and Computers, HCC14 2020* (pp. 281–290). Cham: Springer. https://doi.org/10.1007/978-3-030-62803-1	Conference proceedings [published]	5.3

Appendix B Instructions (First Study Iteration)

In the following, instructions that the participants received in the first study iteration for the roadmapping task and the ethical analyses in the form of text files are presented. Where instructions differed for the bike courier app/teddy bear, they are shown separately. Also, page breaks in the original file are indicated as "___PAGE BREAK___". Please note that some of the instructions shown in the following include typos as I present the instructions in their original formulation and only adapted the general formatting for the presentation here in the appendix.

Instructions for the roadmapping task in the first study iteration

___________________________BEGINNING OF INSTRUCTIONS ___________________________

Here are the steps you need to run through:

1. What do you think are the core **service/product characteristics** that the new bikers' job assignment app/teddy should have?
   a. List these service/product characteristics
   b. Prioritize these characteristics according to their importance and timing
   c. Put the characteristics into a technology roadmap (time axis)
2. Seen the app's service/product characteristics you listed, what **technical capabilities** would Foodora/Fisher-Price need to invest in in order to have the job assignment courier app working in the way envisioned/be the market leader in the digital teddy bear business? (Investment could reside in purchasing IP, purchasing components or building and innovating in-house...)
   a. Align the technical capabilities needed with the service/product characteristics you identified
   b. Put the technical capabilities into your technology roadmap.

BIKE COURIER APP____

3. Briefly think about potential competitors of Foodora. Do you think the bikers' app can create a competitive difference for the company? And if so, does the competitive analysis add any points to your roadmap of technical capabilities? If so, please add these technical capabilities to your roadmap.
4. You have the option to not fully digitalize and automate the job assignment courier app. Seen this alternative, do you want to go for a digitalization of all service characteristics, just parts of them, or not digitalize at all? Please describe what you consider best.

TEDDY BEAR____

3. Briefly think about a potential competitor for Fisher-Price in this segment and what might be the competitive strategy of this competitor? Does the competitive analysis add any points to your roadmap of technical capabilities? If so, please add these technical capabilities to your roadmap.
4. Taken together your estimates of the market, the technical needs and the capabilities, would you invest in the digitalization of the teddy bear?

__________________________________PAGE BREAK __________________________________

What do you think are the core **service/product characteristics** of the bikers' job assignment app/driving demand for them now and in the next 10 years?

List these service/product characteristics AND prioritize them according to their importance and timing

1.
2.
3.
4.
5.
6.
7.

__________________________________PAGE BREAK __________________________________

Seen the service/product characteristics you listed what **technical capabilities** would Foodora/Fisher-Price need to invest in in order to be the market leader in food delivery/the digital teddy bear business? (Investment could reside in purchasing external IP, purchasing components or building and innovating in-house /together with 'ITforYou'…)

Align the technical capabilities needed with the product characteristics you just identified! There may be more than one technical capability needed for a service/product characteristic.

Product Characteristic **Main Technical Capabilities needed**

__________________________________PAGE BREAK __________________________________

3. Put the service/product characteristics and technology capabilities into a technology roadmap that spans the next 5 years. You have seen what a technology roadmap looks like (see below). For this exercise, you only need to **plot the product and technology** rows as they naturally derive from your prior analysis.

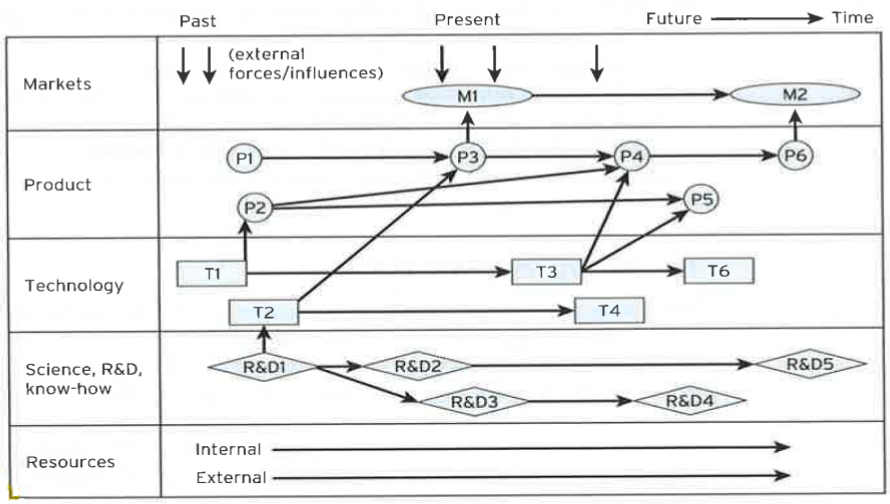


FIGURE 4.10 Technology roadmap
Source: Adapted from Albright and Kappel, 2003

Please sketch your roadmap! (on a separate piece of paper)
When you are done, briefly think about a potential competitor for Foodora/Fisher-Price in this segment and what might be the competitive strategy of that competitor. Does the competitive analysis add any points to your service/product roadmap or technical capabilities? If so, please add these issue to your roadmap.

You have the option to not fully digitalize and automate the job assignment courier app. Seen this alternative, do you want to go for a digitalization of all service characteristics, just parts of them, or not digitalize at all? Please describe what you consider best.

_____________________________END OF INSTRUCTIONS _____________________________

Instructions for the ethical analyses in the first study iteration

__________________________BEGINNING OF INSTRUCTIONS __________________________

Put yourself again in the shoes of the product manager for the Foodora App/smart teddy bear. Two weeks ago you formed an innovation idea around the new digital teddy bear. You came up with a technical roadmap draft.

Now you are about to deepen the new product's 'value proposition'. The executive board of the company only wants to go ahead with investing in the foodora app/teddy bear's digital version if you recommend doing so and only if you have a clear message for it in terms of value creation and harms considered. To prepare for this, you are running through 4 steps of value analysis introduced by an upfront stakeholder analysis.

1. **Stakeholder Identification**

2. **Utilitarian Analysis: Applying *General* Utilitarianism …**
    a. Identify benefits and harms associated with the Foodora App/teddy bear version as you envisioned it in the roadmapping exercise.
    b. For all benefits and harms reflect on what 'values' they actually relate to.
    c. As you conduct the value analysis note down all product characteristics that come to mind to foster certain values and impede the breach of values threatened.
    d. Based on steps 2.1. to 2.3. conduct a utilitarian weighing exercise and take a decision on whether you would recommend investing in the technology based on the utilitarian score.

3. **Virtue Ethical Analysis**
    a. Note down the most important virtues of the bike drivers fostered by using the Foodora app/in the children playing with the teddy bear over a longer period of time that might be negatively impacted it.
    b. Note down the most important virtues of the bike drivers undermined by using the Foodora app/virtues undermined in the children playing with the teddy bear over a longer period of time that might be positively fostered by it.
    c. As you conduct the virtue analysis note down all product characteristics that come to mind and could be added to the roadmap to foster certain virtues and impede negative virtue effects.
    d. Based on steps 3.1. to 3.3. would you invest in the technology?

Note: If you feel there are no virtues impacted by the technology, please don't feel obliged to come up with anything here!

4. **Deontological Analysis**
    a. Could the investment in the technology undermine any values that you hold dear because of your personal MAXIMS?
    b. Could the investment in the technology foster any values that you hold dear because of your personal MAXIMS?
    c. As you conduct the deontological analysis note down all product characteristics that come to mind and could be added to have the technology to live up to your maxims.
    d. Based on steps 4.1. to 4.3. would you invest in the technology?
    e. Would you treat humanity as a means only when investing in this technology?

    Note: If there are no maxims of yours touched, please don't feel obliged to come up with anything here!

__________________________________PAGE BREAK __________________________________

FORM
Stakeholder Analysis

Note down the direct and indirect stakeholders that the Foodora app/teddy bear has.

__________________________________PAGE BREAK __________________________________

FORM
General Utilitarian Analysis

Remember that General Utilitarian Analysis asks „What would happen if *everyone* were to do so-and-so in such cases?"

- Identify benefits and harms associated with the Foodora App version from your roadmap/teddy bear you envisioned [stating in brackets for what direct or indirect stakeholders these are true]
- For all benefits and harms reflect on what 'values' they actually relate to.
- As you conduct the value analysis note down all product characteristics that come to mind /and could be added to the roadmap/ to foster certain values and impede the breach of values threatened.
- Based on the steps above conduct a utilitarian weighing exercise and take a decision on whether you would recommend investing in the technology based on the utilitarian score.

Come up with as much as you want and can and find sensible here!

"What benefits would arise if everyone were to build and/or deploy the Foodora App/teddy bear in the way you envisioned it?" (IN BRACKETS GIVE A VERY SHORT EXPLANATION OF WHAT YOU MEAN) [Stakeholders?]	Related Values	Which product characteristics could foster/protect this value?

+ please add row if needed

__________________________________PAGE BREAK __________________________________

“What harms would arise if everyone were to build and/or deploy the Foodora App/teddy bear in the way you envisioned it? (IN BRACKETS GIVE A VERY SHORT EXPLANATION OF WHAT YOU MEAN) [stakeholders?]	Related Values	Which product characteristics could foster/protect this value?

+ please add row if needed

Utilitarian Calculus
ENSURE THAT YOU ENTER ALL YOUR VALUES FROM ABOVE INTO THIS TABLE AND CALCULATE THE RESULT CONSIDERING YOUR WEIGHTS!
(1 = very **un**important value benefited or harmed; 5 = very important value benefited or harmed).
As you are weighing the values, imagine that you are judging the envisioned system values from behind a “veil of ignorance”.

You may reckon that some of the benefits and harms above led to the same values. This is fine! Just make sure that you enter the respective (potentially important) value here ***once*** and consider the repetition in your weight.

Positive Values (as identified above)	**Weights**	**Negative Values** (as identified above)	**Weights**

+ please add row if needed
Sums?
BASED JUST ON THE UTILITARIAN ANALYSIS: WOULD YOU INVEST?

_______________________________PAGE BREAK _______________________________

FORM
Virtue Ethical Analysis

Remember: Virtue is the constitution of goodness of a person. The *virtues* of a person make him or her a good person. Virtue often shows itself in well-balanced behaviour (golden mean). It can be the result of good *habits.*
Could the technology undermine or foster the virtuous character of bikers/kids in the long run?

1. Note down the most important virtues of bikers using the Foodora App/children playing with the teddy bear that might be negatively impacted by it in the long run.
2. Note down the most important virtues of bikers using the Foodora App/the children playing with the teddy bear that might be positively fostered by it in the long run.
3. As you conduct the virtue analysis note down all product characteristics that come to mind and could be added to the roadmap to foster certain virtues and impede the negative virtue effects.
4. Based on steps 1 to 3 do you recommend investing in the technology?
   Note: If you feel there are no virtues /or vices/ impacted by the technology, please don't feel obliged to come up with anything here!

Come up with as much as you want and can and find sensible here!

Virtues undermined? (IN BRACKETS GIVE A VERY SHORT EXPLANATION OF WHAT YOU MEAN)	Which product characteristics could foster/protect these virtues?

+ please add row if needed

____________________________________PAGE BREAK ____________________________________

Virtues fostered? (IN BRACKETS GIVE A VERY SHORT EXPLANATION OF WHAT YOU MEAN)	Which product characteristics could foster/protect these virtues?

+ please add row if needed

BASED JUST ON THE VIRTUE ETHICAL ANALYSIS: WOULD YOU INVEST? GIVE A CLEAR YES/NO ANSWER AND PROVIDE SHORT REASON

__________________________________PAGE BREAK __________________________________

FORM

Deontological Analysis

Remember that deontological analysis looks at the morality of acts. In this case, it is your act of investment in the digital routing app for Foodora/digitalization of the teddy bear that is the object of analysis. You should decided on the morality of this investment with the help of the categorical imperative that draws on your maxims, their universality and the question of whether you treat humanity as a means only through this investment. Your personal maxims are principles you wish for and act upon yourself.

1. Could the investment in the technology undermine any of your personal maxims, which you would consider to be of universal significance?
2. Could the investment in the technology foster any of your personal maxims, which you would consider to be of universal significance?
3. As you conduct the deontological analysis note down all product characteristics that come to mind and could be considered in the technology's roadmap to not undermine your maxims.
4. Would you treat humanity as a means only when investing in this technology?
5. Based on steps 1 to 3. do you recommend investing in the technology?

Note: If there are **no** maxims of yours touched, please don't feel obliged to come up with anything here!

Note personal maxims potentially undermined, which you consider to be of universal relevance and where you believe there is a duty to consider them in the present investment (IN BRACKETS GIVE A VERY SHORT EXPLANATION OF WHAT YOU MEAN)	Value(s) your maxims are related to	Which product characteristic/s could protect your personal maxims and the related values?

+ please add row if needed

__________________________________PAGE BREAK __________________________________

Note personal maxims <u>potentially fostered</u>, which you consider to be of universal relevance and where you believe there is a duty to consider them in the present investment (IN BRACKETS GIVE A VERY SHORT EXPLANATION OF WHAT YOU MEAN)	Value(s) your maxims are related to	Which product characteristic/s could protect your personal maxims and the related values?

+ please add row if needed

By investing in the digital teddy bear as you have been thinking of it up to here (with all your ideas on product characteristics in mind): Do you think that you are using any of the humans involved here as a "means only"?
PLEASE DISCUSS THIS POINT!

BASED *JUST ON* THE DEONTOLGOICAL ETHICAL ANALYSIS: WOULD YOU INVEST? GIVE A CLEAR YES/NO ANSWER AND PROVIDE SHORT REASON

__________________________________PAGE BREAK __________________________________

YOUR FINAL DECISION:
Do you invest? YES/NO PLEASE PROVIDE A FINAL REASONING

Please also note:

How old are you?

What is your nationality?

Did you study any other subject than business management, economics or business informatics before you joined this course? If yes, which one?

______________________________END OF INSTRUCTIONS ______________________________

Appendix C Instructions (Second Study Iteration)

Instructions for the roadmapping task in the first study iteration

In the second study iteration, the participants first conducted the roadmapping task as in the first study iteration. However, this time they entered their ideas in an online interface using the statistical survey web app LimeSurvey. They first uploaded a picture of their roadmap, then inserted product characteristics including descriptions. The participants could enter up to 30 stakeholders and 50 product characteristics. Finally, they were asked to provide a recommendation for an investment in the IT product. The instructions shown in the following are not screenshots from the original interface but represent the structure of the interface as closely as possible.

__________________________BEGINNING OF INSTRUCTIONS __________________________

“Before you get started….”

Please enter your team members' surnames ("Name1 & Name2").

__________________________________PAGE BREAK __________________________________

Stakeholder Analysis

Note down the stakeholders* that are directly or indirectly affected by the product/service.
*Stakeholders are individuals or organizations having a right, share, claim, influence or interest in a system or system characteristics.

Please note down the stakeholders affected by the product. **Stakeholder 1**	
Stakeholder	
directly or indirectly affected?	

Please note down the stakeholders affected by the product. **Stakeholder 2**	
Stakeholder	
directly or indirectly affected?	

…

__________________________________PAGE BREAK __________________________________

Product-Technology Roadmap

Please upload your product-technology roadmap and insert the product characteristics from your operational concept below.

Please upload your product-technology roadmap.

-- OPTION FOR UPLOADING A FILE --

Please insert the product characteristics from your roadmap analysis.

Product characteristic 1	
Product characteristic	
Description	

Product characteristic 2	
Product characteristic	
Description	

…

Would you recommend to invest in the product that you described above?

☐ Yes ☐ No

Please explain.

In case you had difficulties answering these questions, you can leave a comment for us here.

You have completed the product roadmap analysis.

_____________________________END OF INSTRUCTIONS _____________________________

Instructions for the ethical analyses in the second study iteration

In the second study iteration, the participants entered their ideas with the help of an online interface using the statistical survey web app LimeSurvey. This interface presented every subtask on a separate page, see list below. The participants could choose to go to the previous or next page any time by clicking on the respective buttons and had the option to save their work and continue at a later point in time. Also, they could elect specific pages from an index that they could access at any time by clicking on "index" in the right upper corner of the screen. The instructions shown in the following are not original screenshots but represent the original formatting as closely as possible, including pictures shown in the online interface.

Overview of substasks and pages

- General Intro and Instructions: Ethical IT Product Innovation
- UTILITARIAN ANALYSIS
  - Intro
  - Brainstorming
  - Identification of Harms and Benefits
  - Investment Decision 1
  - Product Improvements
  - Investment Decision 2
- VIRTUE ETHICAL ANALYSIS
  - Intro
  - Brainstorming
  - Identification of Characteristics of Behaviour and Character
  - Investment Decision 1
  - Product Improvements
  - Investment Decision 2
- DEONTOLOGICAL ANALYSIS
  - Intro
  - Brainstorming
  - Personal Maxims
  - Investment Decision 1
  - Product Improvements
  - Investment Decision 2
- Importance of Identified Values (Considering All Three Ethical Analyses)
- Importance of Suggested Product Changes (Considering All Three Ethical Analyses)
- Final Investment Decision (Considering All Three Ethical Analyses)
- Last Page

____________________________ BEGINNING OF INSTRUCTIONS ____________________________

General Intro and Instructions

Ethical IT Product Innovation

Put yourself in the shoes of the product manager for the envisioned IT product again.

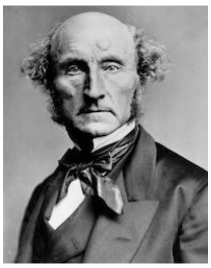
You formed an innovation idea around the new product and came up with an operational concept based on a product roadmap. Now, you will deepen the new product's value proposition.

The executive board of the company only wants to go ahead with investing in the product if you recommend doing so based on the values created and harms considered.

To prepare for this, you are running through three additional steps of ethical value analysis.

UTILITARIAN ANALYSIS: Intro

"Everyone ought to act so as to bring about the greatest amount of happiness for the greatest number of people"



John Stuart Mill (1806-1873), one of the most prominent proponents of utilitarianism.

In the following, conduct a detailed ethical value analysis of benefits and harms (utilitarian ethics):

a. Identify benefits that could be enabled from the system of interest in the long run.
b. Identify harms that could arise from the system of interest in the long run.
c. Elicit the human values that underlie the identified effects.
d. Note down potential ethically aligned improvements for the operational concept.

Brainstorming (Utilitarianism)

Take pen and paper.

Considering the initial operational concept that you came up with during the roadmap analysis, brainstorm what **BENEFITS AND HARMS** could arise from the system of interest in the long run.

Identification of Harms and Benefits (Utilitarianism)

Note. Additional fields automatically appeared when participants started to fill in the "Description" of a benefit/harm. For example, when working on "Benefit/harm 2", fields for "Benefits/harm 3" appeared.

You have now brainstormed what **beneficial and harmful effects** the system of interest as described in the operational concept based on the roadmap could have.

Please take your ideas and insert them into the fields below.

EXAMPLE: Digital Teddy Bear

Benefit/harm 1

	Description	Stakeholder(s) affected	beneficial or harmful?	Which value does this relate to?
Note down the beneficial or harmful effects of the product.	The child has less social contact with other children and thus does not develop good social skills.	Children	harmful	Social skills

Benefit/harm 1

	Description	Stakeholder(s) affected	beneficial or harmful?	Which value does this relate to?
Note down the beneficial or harmful effects of the product.				

Benefit/harm 2

Leave blank if you do not want to add more ideas.

	Description	Stakeholder(s) affected	beneficial or harmful?	Which value does this relate to?
Note down the beneficial or harmful effects of the product.				

Investment Decision 1 (Utilitarianism)

Taking into consideration your utilitarian analysis above,
would you recommend to invest in the product as described in your <u>initial</u> operational concept?

☐ Yes ☐ No

Please explain.

If you have questions or comments, you can leave a message for us here.

Product Improvements (Utilitarianism)

Please note that additional fields automatically appeared when the participants started to fill in "Improvement 1". The participants could enter up to 10 improvements.

You have identified beneficial and harmful effects of the system of interest that you initially described in your operational concept.

Now reflect on how you could refine product characteristics of the system to
a) further foster the benefits and
b) protect from the harms that you identified.

Note down your improvements for the operational concept in the fields below.

EXAMPLE: Digital Teddy Bear

Targeting benefit/harm 1:
"The child has less social contact with other children and thus does not develop good social skills."

	Note down potential ethically aligned improvements for the operational concept.
Improvement 1	Teddy bear does not have many interaction capabilities
Improvement 2	Teddy bear provides games that can be played by multiple players

Targeting benefit/harm 1:

"Text from field [Description] of Benefit/Harm 1"

Note down potential ethically aligned improvements for the operational concept.

Improvement 1

Investment Decision 2 (Utilitarianism)

Would you recommend to invest if the product characteristics of the system were adapted as described in the utilitarian analysis above?

☐ Yes ☐ No

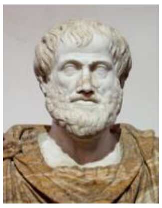
Please explain.

If you have questions or comments, you can leave a message for us here.

VIRTUE ETHICAL ANALYSIS: Intro

Real satisfaction and happiness (Greek: *eudaimonia*) can only be achieved through a virtuous lifestyle.

Virtue often shows itself in well-balanced behaviour (golden mean) and can be the result of good habits.



Aristotle (384-322 BC), one of the most prominent proponents of virtue ethics.

In the following, conduct a detailed ethical value analysis of good and bad characteristics of behaviour and character (virtue ethics):

a. Identify good characteristics of behaviour and character (virtues) that could be encouraged in a human being using the system of interest in the long run.
b. Identify bad characteristics of behaviour and character (vices) that could arise in a human being from using the system of interest in the long run.
c. Elicit the virtues that underlie the identified effects.
d. Note down potential ethically aligned improvements for the operational concept.

Brainstorming (Virtue ethics)

Take pen and paper again.

Considering the initial operational concept that you came up with during the roadmap analysis, brainstorm how good and bad characteristics of **BEHAVIOUR and CHARACTER** (virtues and vices) could arise in a human being by using the system of interest in the long run.

Identification of Characteristics of Behaviour and Character (Virtue ethics)

You have now brainstormed what good and bad characteristics of **behaviour and character** could arise from the system of interest as described in the operational concept based on the roadmap.

Please take your ideas and insert them into the fields below.

EXAMPLE: Digital Teddy Bear

Virtue/vice 1

Note down how the product influences the character or behaviour of the stakeholders	Description	Stakeholder(s) affected	beneficial or harmful?	Which value or virtue does this relate to?
	When the child plays with the teddy bear, the toy reacts and replies immediately. Because of that, the child does not learn to be patient.	Children	harmful	Patience

Virtue/vice 1

	Description	Stakeholder(s) affected	beneficial or harmful?	Which virtue does this relate to?
Note down how the product influences the character or behaviour of the stakeholders.				

Virtue/vice 2
Leave blank if you do not want to add more ideas.

	Description	Stakeholder(s) affected	beneficial or harmful?	Which virtue does this relate to?
Note down how the product influences the character or behaviour of the stakeholders.				

Investment Decision 1 (Virtue ethics)

Taking into consideration your virtue-ethical analysis above,
would you recommend to invest in the product as described in your initial operational concept?

☐ Yes ☐ No

Please explain.

If you have questions or comments, you can leave a message for us here.

Product Improvements (Virtue ethics)

You have identified good and bad characteristics of behaviour and character
that could arise from the system of interest that you initially described in your operational concept.

Now reflect on how you could refine product characteristics of the system to

a) further foster good characteristics (virtues) and
b) avoid bad characteristics (vices) that you identified.

Note down your improvements for the operational concept in the fields below.

EXAMPLE: Digital Teddy Bear

Targeting benefit/harm 1:
“When the child plays with the teddy bear, the toy reacts and replies immediately. Because of that, the child does not learn to be patient.“

	Note down potential ethically aligned improvements for the operational concept.
Improvement 1	Some functions of the teddy bear have a time lag.
Improvement 2	Teddy bear provides games where children have to wait, f.ex. for a plant to grow in a game.

Targeting virtue/vice 1:

“Text from field [Description] of Virtue/vice 1”

	Note down potential ethically aligned improvements for the operational concept.
Improvement 1	

Investment Decision 2 (Virtue ethics)

Would you recommend to invest if the product characteristics of the system
were adapted according to the improvements enlisted above?

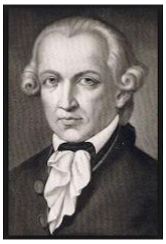
☐ Yes ☐ No

Please explain.

If you have questions or comments, you can leave a message for us here.

DEONTOLOGICAL ANALYSIS: Intro

"Act only according to that maxim whereby you can, at the same time, will that it should become a universal law." - The Categorical Imperative by Immanuel Kant -



Immanuel Kant (1724-1804), one of the most prominent proponents of deontology.

In the following, conduct a detailed ethical value analysis based on your core ethical principles and commitments = your personal maxims (deontology):

a. Identify how the system of interest supports your personal maxims in the long run.
b. Identify how the system of interest undermines your personal maxims in the long run.
c. Elicit the human values that underlie the identified effects.
d. Note down potential ethically aligned improvements for the operational concept.

Brainstorming (Deontology)

Take pen and paper again.

Considering the initial operational concept that you came up with during the roadmap analysis, brainstorm how, in the long run, the system of interest could support or undermine any of your **PERSONAL MAXIMS*** that you consider to be of universal significance.

*Your personal maxims are ethical principles you wish for and act upon yourself.

Personal Maxims (Deontology)

You have now brainstormed how your **personal maxims** of universal significance could be supported or undermined by the system of interest that you initially described in your operational concept.

Please take your ideas and insert them into the fields below.

EXAMPLE: Digital Teddy Bear

Personal maxim 1

Note down how the product supports or undermines your personal maxim.	Description	Stakeholder(s) affected	beneficial or harmful?	Which value does this relate to?
	I personally think that it is important that parents spend a lot of time with their children. Because of the digital teddy bear and its many capabilities, parents might spend less time with their children.	Children; parents	harmful	Family time

Personal maxim 1

Note down how the product supports or undermines your personal maxim.	Description	Stakeholder(s) affected	beneficial or harmful?	Which value does this relate to?

Personal maxim 2
Leave blank if you do not want to add more ideas.

Note down how the product supports or undermines your personal maxim.	Description	Stakeholder(s) affected	beneficial or harmful?	Which value does this relate to?

Investment Decision 1 (Deontology)

Taking into consideration your deontological analysis above,
would you recommend to invest in the product as described in your <u>initial</u> operational concept?

☐ Yes ☐ No

Please explain.

If you have questions or comments, you can leave a message for us here.

Product Improvements (Deontology)

You have identified personal maxims that are supported or undermined by the system of interest that you initially described in your operational concept.

Now reflect on how you could refine product characteristics of the system to

a) further support your personal maxims and
b) protect your personal maxims from being undermined.

Note down your improvements for the operational concept in the fields below.

EXAMPLE: Digital Teddy Bear

Targeting personal maxim 1:
"I personally think that it is important that parents spend a lot of time with their children. Because of the digital teddy bear and its many capabilities, parents might spend less time with their children. "

	Note down potential ethically aligned improvements for the operational concept.
Improvement 1	Digital teddy bear does not take over tasks for parents
Improvement 2	…

Targeting personal maxim 1:

"Text from field [Description] of Personal maxim 1"

Note down potential ethically aligned improvements for the operational concept.

Improvement 1

Investment Decision 2 (Deontology)

Would you recommend to invest if the product characteristics of the system were adapted according to the improvements enlisted above?

☐ Yes ☐ No

Please explain.

If you have questions or comments, you can leave a message for us here.

Importance of Identified Values (Considering All Three Ethical Analyses)

The table shown in the following listed all benefits/harms, virtues/vices and personal maxims that the participant had entered in the analyses before.

Categorize the values' importance according to the following criteria:

- Such that you consider your own ethical principles or what Kant called "Personal Maxims".
- Such that the organization will not use people merely as a means to some end.

Categorize the values according to their importance:

	not at all important 1	2	3	4	5	6	very important 7	*categorized already*
Benefit/harm 1	○	○	○	○	○	○	○	○
Benefit/harm 2	○	○	○	○	○	○	○	○
…	○	○	○	○	○	○	○	○
Virtue/vice 1	○	○	○	○	○	○	○	○
Virtue/vice 2	○	○	○	○	○	○	○	○
…	○	○	○	○	○	○	○	○
Personal maxim 1	○	○	○	○	○	○	○	○

Personal maxim 2	○	○	○	○	○	○	○	○
...	○	○	○	○	○	○	○	○

Importance of Suggested Product Changes (Considering All Three Ethical Analyses)

Which changes to the operational concept that you suggested in the three ethical analyses do you consider the most important ones?

Go back to the conducted analyses and look at your suggested product changes again.
[Go to "Question index" (top right) and choose the "Product Changes" pages]

Pick the 3 most important product changes for every ethical analysis and copy them into the fields below

Go to "UTILITARIAN ANALYSIS: Product Changes" and look at your suggested product changes again.

Pick the 3 product changes that you consider the most important ones and copy them into the fields below.

	Note down the most important product changes.
Prioritized product change 1	
Prioritized product change 2	
Prioritized product change 3	

Go to "VIRTUE-ETHICAL ANALYSIS: Product Changes" and look at your suggested product changes again.

Pick the 3 product changes that you consider the most important ones and copy them into the fields below.

	Note down the most important product changes.
Prioritized product change 1	
Prioritized product change 2	
Prioritized product change 3	

Go to "DEONTOLOGICAL ANALYSIS: Product Changes" and look at your suggested product changes again.

Pick the 3 product changes that you consider the most important ones and copy them into the fields below.

	Note down the most important product changes.
Prioritized product change 1	
Prioritized product change 2	
Prioritized product change 3	

Final Investment Decision (Considering All Three Ethical Analyses)

Consider the system of interest that you initially described in your operational concept and all the product changes that you came up with in the three ethical analyses and make a final investment decision.

Would you recommend to invest if the product characteristics of the system
were adapted according to the improvements enlisted in all the three ethical analyses?

☐ Yes ☐ No

Please explain.

If you have questions or comments, you can leave a message for us here.

Last Page

You have completed the ethical product innovation analysis exercise.

Congratulations!

We're curious about your results

_____________________________END OF INSTRUCTIONS _____________________________

Appendix D Category System

The following tables show all five category groups that emerged from the qualitative data, i.e., the participants' idea descriptions and related values/virtues: intrinsic values (Table D1), instrumental values (Table D2), virtues (Table D3), personal characteristics and abilities (Table D4), emotions (Table D5) and product characteristics (Table D6). For each category group, all subsumed categories are described. For intrinsic values, instrumental values, and virtues, categories are arranged in value classes (e.g., individual values or social values). Due to their different meanings in context, "Loyalty" and "Availability" come up twice in different category groups.

Table D1. Intrinsic values

Value class	
Category	Description of category
Value class: Environmental values	
Environmental protection	The product/service/system is produced or designed in a way that reduces or avoids harm done to the natural environment, e.g., by helping to reduce waste or car emissions
Environmental protection [harmed]	The product/service/system is produced or designed in a way that does not avoid or causes harm to the natural environment, e.g., causes pollution through waste or use of non-renewable energy such as fossil fuels
Value class: Individual values	
Autonomy	The product/service/system supports the person's ability to make his/her own decisions and act independently
Autonomy [harmed]	The product/service/system does not support the person's ability to make his/her own decisions or even prevents him/her from acting independently
Dignity	The product/service/system supports human dignity, e.g., by supporting humane treatment of people
Dignity [harmed]	Because of the product/service/system, human dignity is undermined as people feel humiliated (e.g., because of having to wear a pink uniform), used merely as a means to an end, or rated through numbers
Freedom	The product/service/system fosters freedom, that is, it enables or supports the person's state of being free, without any (external) constraints
Freedom [harmed]	The product/service/system undermines freedom, that is, it restrains the person's state of being free, e.g., through external measures such as regulations or surveillance

Health	The product/service/system is designed in a way that supports the health of the user or customer, e.g., by supporting healthy nutrition or providing health advice or healthcare
Health [harmed]	The product or system does not support the health of the user or customer or even decreases it, e.g., by encouraging unhealthy nutrition
Independence	The product/service/system fosters independence, that is, the user or customer is not dependent on someone or something (machine/system) else
Independence [harmed]	The product/service harms independence or creates/fosters dependence, e.g., restaurants or bikers become dependent on the application
Innocence [harmed]	The product/service/system harms innocence, e.g., by imposing success barometers on a child's development
Knowledge/education	The product/service/system informs the user well, supports the user's learning (e.g., by adjusting teaching methods), understanding, comprehension and education, acts as a teacher, increases the user's knowledge and skills (e.g., language skills)
Knowledge/education [harmed]	The product/service/system harms people's knowledge or does not support their learning and education, e.g., through misleading information
Loss of identity [neg.]	The product/service/system does not protect or leads to the loss of the user' or customer's identity, e.g., because of job loss or dependence on technology
Mental, psychological health	The product or system is designed in a way that ensures that the user or customer is mentally well and supports his/her psychological health, e.g., is not manipulative
Mental, psychological health [harmed]	The product or system is designed in a way that does not ensure that the user or customer is mentally well or harms his/her psychological health, e.g., shows content that is not appropriate (for the age of the user)
Personal growth	The product/service/system fosters personal growth, that is, striving for excellence, giving your best, and self-improvement
Personal growth [harmed]	The product/service/system harms or does not support personal growth, that is, it prevents people from striving for excellence, giving their best and self-improving
Privacy	The product/service/system ensures the privacy/data protection of the user or customer, and/or protects personal data e.g., through anonymity, appropriate privacy policies, asking for consent, and/or protects the user/customer against surveillance etc.
Privacy [harmed]	The product/service/system does not ensure the privacy/data protection of the user or customer, does not protect personal data, or enables the surveillance of the user/customer etc.
Purpose, meaningfulness, idealism	The product/service/system fosters the feeling of having a purpose, perceiving the meaningfulness of one's life, being able to live according to one's idealism or fulfilment

Safety	The product/service/system is designed in a way that ensures and fosters the safety of the user or customer, e.g., by watching over a child
Safety [harmed]	The product/service/system is designed in a way that decreases or endangers the safety of the user or customer
Satisfaction/happiness	The product/service satisfies the user, the user is pleased with his/her situation, experiences positive emotions, pleasure, happiness and contentment, well-being
Satisfaction/happiness [harmed]	The product/service/system does not lead to user happiness or satisfaction
Social/legal security	The product/service/system supports measures that ensure the social and/or legal security of the users/customers/employees, e.g., basic coverage and insurance or (better) legal protection
Social/legal security [harmed]	The product/service/system does not support measures that ensure social security of the users/customers/employees, e.g., basic coverage and insurance or (better) legal protection
Value class: Social-individual values	
Belongingness	The product/service/system fosters (the sense of) belonging/belongingness, e.g., between a waiter in a restaurant and customers, among bike couriers, etc.
Belongingness [harmed]	The product/service/system decreases (the sense of) belonging/belongingness, for example because of reduced human contact, e.g., between a waiter in a restaurant and customers, among bike couriers, etc.
Trust	The product/service/system fosters trust in other people
Trust [harmed]	The product/service/system harms or does not support trust in other people
Value class: Social-technical values	
Friendship (machine-human)	The product or system is a friend to the user or customer
Value class: Social values	
Better world	The product/service/system contributes to a better world
Development of society	The product/service/system supports positive societal developments
Equality	The product/service/system is produced or designed in a way that ensures that everyone can do the same thing despite different resources and skills; see “Accessibility” for the specific description of an accessible design
Equality [harmed]	The product/service/system is produced or designed in a way that decreases the chances that everyone can do the same thing despite different resources and skills (i.e., they have equal opportunities); but see “Accessibility [harmed]” for the specific description of an accessible design

Fairness	The product/service/system fosters a fair and just state, behaviour, or system, e.g., through fair and objective decisions or by preventing misuse or abuse; if the focus lies on the person, "Truthfulness, honesty" or "Corruptibility [neg., prevented]" might offer a better option
Fairness [harmed]	The product/service/system undermines a fair and just state, behaviour, or system, e.g., through misuse or abuse; if the focus lies on the person, "Truthfulness, honesty [harmed]" or "Corruptibility [neg.]" might offer a better option
Friendship (human-human)	The product/service/system fosters friendships between people
Friendship (human-human) [harmed]	The product/service/system endangers/harms friendships between people
Love	The product/service/system fosters love, e.g., among parents and children
Love [harmed]	The product/service/system harms/decreases love, e.g., among parents and children

Table D2. Instrumental values

Value class	
Category	**Description of category**
Value class: Economic values	
Availability of employees	The product/service/system is designed in a way that ensures that the company's employees are always available
Competitive power	The product/service/system increases the company's power, e.g., within the market or with regard to the customers
Competitive power [harmed]	The product/service/system decreases the company's power, e.g., within the market or with regard to the customers
Credibility [harmed]	The product/service/system inspires actions that harm the credibility of the product/service or those involved, e.g., the company
Efficiency & optimization	The system helps to make something faster or optimizes it another way, e.g., by reducing unnecessary processes ("overhead"), adapting to demand, leading to higher effectiveness, or by efficient matching, e.g., of patients and doctors or bikers and restaurants
Efficiency & optimization [harmed]	The product/service/system makes something less efficient
Errors and misunderstandings [neg. prevented]	The product/service/system helps to avoid/leads to fewer errors, misunderstandings, misinterpretations, e.g., wrong orders

Errors and misunderstandings [neg.]	The product/service/system does not avoid errors/leads to more errors, misunderstandings, misinterpretations, e.g., wrong orders
High quality service	The product/service/system is described or perceived as enabling or maintaining a good, high quality, or even "the best" service/product (fast, successful, reliable, accurate, on time, serious, qualified …) or offers high quality sound, material etc.
High quality service [harmed]	The product/service/system does not support, but rather harms/endangers a good/high quality service/product (fast, successful, reliable, accurate, on time …)
Innovation	The product/service/system fosters innovation by supporting the development of new products and processes, as well as the improvement of existing ones
Job positions & opportunities	The product/service/system has a positive impact on jobs, e.g., by creating new jobs or positions or guaranteeing job stability
Job positions & opportunities [harmed]	The product/service/system has a negative impact on jobs, e.g., (potential) job loss, fewer jobs, fewer career opportunities
Monetary benefits	The product/service/system is affordable, for free or supports measures that have a positive monetary impact on customers, e.g., lower prices for the costumer
Monetary benefits [harmed]	The product/service/system is not affordable, expensive, or has a negative monetary impact on customers, e.g., higher prices for the costumer
Novelty, diversity	The product/service/system fosters diversity and/or novelty, by suggesting new things (e.g., new meals) or a variety of things, encouraging to try out new things (e.g., different food), not sticking with routines, e.g., because different types of service or of product are offered
Novelty, diversity [harmed]	The product/service/system harms/decreases/does not support diversity and/or novelty, for example, by (not) suggesting new things (e.g., new meals) or a variety of things etc.
Productivity, profit, money	The system or product has a monetary impact on stakeholders, e.g., earning more money, increasing wealth or profits, expanding business, saving on costs, new investment possibilities, better performance
Productivity, profit, money [harmed]	The product/service/system leads to a reduced profit, prosperity, or wealth (for the company)
Simplicity	The product/service/system is simple or helps to make something less complex
Visibility & reputation	The product promotes the visibility and reputation of companies/restaurants (sometimes referred to as "recognition")
Visibility & reputation [harmed]	The product does not promote, but rather harms the visibility and reputation of companies/restaurants (sometimes referred to as "recognition")

Work capacities	The product/service/system increases capacities for people in their work, e.g., by taking workload from them so they have more time to work on other important tasks
Work capacities [harmed]	The product/service/system decreases capacities for people in their work, e.g., by increasing their workload so they have less time to work on important tasks
Value class: Individual values	
(More) Free time	The product/service/system gives or allows the user to have (more) (free) time, for example by relieving the user of certain tasks
Accuracy	The product/service/system supports accuracy, that is, correct decisions and judgments, e.g., by providing a doctor with good information for making a diagnosis; sometimes referred to as "reliability" of the service
Accuracy [harmed]	The product/service/system undermines accuracy, that is, correct decisions and judgments, e.g., through missing information for a doctor making a diagnosis; sometimes referred to as a lacking "reliability" of the service
Availability	The system is highly available to the user or customer, e.g., "24/7"
Comfort	The product or system fosters comfort, e.g., when the user (e.g., kid or patient) is in distress or afraid
Control	The system grants the user, customer, or company control, e.g., over the process, over the device, over the application, over the menu etc.
Control [harmed]	The system undermines the user's, customer's, or company's control, e.g., because control over the process, over the device, over the application, over the menu etc. is lost/decreased
Convenience	The product/service is convenient to use or increases convenience, e.g., because it makes it possible to place orders online
Corruptibility [neg., prevented]	The product/service/system undermines corruptibility, that is, acting on false information or through payment to increase one's own success or profit, e.g., by providing reliable, objective information
Corruptibility [neg.]	The product/service/system supports corruptibility, that is, acting on false information or through payment to increase one's own success or profit
Flexibility for person	The product/service/system offers options so that the user can adapt it to the situation, e.g., flexible time management, you can work or learn whenever you want
Motivation, Encouragement	The product/service/system motivates or encourages the user/customer to do something, e.g., achieve a goal, do sports
Motivation, Encouragement [harmed]	The product/service/system does not motivate the user/customer to do something e.g., achieve a goal, do sports
Time efficiency (service)	The product/service/system helps to save time by being efficient -> efficiency of the process is emphasized

Value class: Social-individual values	
Physical space [harmed]	Physical space is reduced because of the product/service/system, e.g., the pedestrian or bike lane is crowded because of the bike couriers
Value class: Social-technical values	
Accessibility	The system's design supports people with deficiencies or disabilities (e.g., people with bad eyesight) or occasional technology users (e.g., older people or people who did not grow up with the internet) etc., e.g., by providing an audio guide or a zoom function
Accessibility [harmed]	The system's design does not support people with deficiencies or disabilities (e.g., people with bad eyesight) or occasional technology users (e.g., older people or people who did not grow up with the internet), e.g., because of a complicated design that is not easily accessible for them
Trust in technology	The product/service/system fosters the user's or the whole society's trust in technology
Trust in technology [harmed]	The product/service/system harms the user's or the whole society's trust in technology
Value class: Social values	
Charity	The product/service/system supports charity, that is, contributes to the common good, e.g., through donations
Child-parent relationship	The product/service/system supports parents spending time with their child/ren, building a loving relationship, getting to know them well, etc.
Child-parent relationship [harmed]	The product/service/system leads to parents neglecting their child/ren, spending less time with them etc.
Community	The product/service/system helps to bring people together, e.g., by enforcing teamwork or planning meetings and events, or by allowing users to invite other people—also people they don't know, e.g., to have dinner together, delivery to public places or family/group accounts so that people can have meals together, etc.
Cooperation	The product/service fosters cooperation, that is, people working together, being connected, e.g., with colleagues (to achieve something)
Cooperation [harmed]	The product/service harms cooperation, that is, people working together, being connected, which might lead to reduced communication and isolation
Family (time) [harmed]	Because of the product, the user spends less time with his/her family, for example because family dinners become rare as everyone orders food
Human contact	The product/service/system fosters human contact, that is, social or personal interactions
Human contact [harmed]	The product/service/system harms human contact, that is, social or personal interactions and thereby social behaviour, e.g., no direct contact with people

	(e.g., customers), no quality time spent with people, no face-to-face interactions, having to work alone, isolation
Legal compliance	The product/service/system fosters compliance with legal regulations
Legal compliance [harmed]	The product/service/system makes legal compliance difficult, e.g., by opening up legal questions that are not easily resolved
Value class: Technical values	
Aesthetics, nice design	The system shows/does not show advertisement
Availability	The system operates around the clock and is thus available “24/7”
Durability	The physical product is designed in a way that fosters durability
Durability [harmed]	The physical product is not designed in a way that fosters durability
Ease of maintenance	The physical product or system is designed in a way that guarantees easy maintenance
Ease of maintenance [harmed]	The physical product or system is designed in a way that is prone to difficult maintenance
Ease of use	The product or system or specific product functions (e.g., setting up the account or assigning courier jobs) are referred to as “easy to use”, “easy”, “convenient”, “intuitive”, “simple”, “clear”, “user-friendly”, or “usable”; can involve “good user experience”
Ease of use [harmed]	The product or system or specific product functions are not easy to use
IT security	The system is based on IT principles (e.g., confidentiality, integrity, authentication, encryption, biometric/face/fingerprint identification) which ensure that it is secure, cannot be hacked etc.
IT Security [harmed]	The system is either not based on IT principles (e.g., confidentiality, integrity, authentication, encryption, biometric/face/fingerprint identification) which ensure that it is not secure, can be hacked or is not protected from third parties
Personalization, customization	The product/service/system can be (=setting options) or is already (=specific settings or characteristics) adapted to the user’s skills (e.g., biker-friendly roads, age-appropriateness) and/or the user's preferences (e.g., language)
Personalization, customization [harmed]	The product/service/system is not or cannot be adapted to the user’s skills or preferences
Reliability & robustness	The system does not easily fail, is stable and reliable
Reliability & robustness [harmed]	The system easily fails/crashes, is unstable or unreliable
Transparency	The system makes something transparent, for example, how a process works; is sometimes listed in combination with “feedback/info” or “evaluation”

Transparency [harmed]	The system undermines transparency, for example, because of a missing feedback or evaluation system

Table D3. Virtues

Value class	
Category	Description of category
Value class: Economic values	
Loyalty	The product/service/system increases the user's or customer's loyalty to the company
Loyalty [harmed]	The product/service/system harms the user's or customer's loyalty
Value class: Individual values	
(Self-)discipline	The product/service/system fosters self-discipline as drivers have to follow navigations, couriers have to deliver food, children need to behave. But see “Perseverance” if the focus is on something being *in spite of* obstacles etc.
(Self-)discipline [harmed]	The product/service/system harms self-discipline
Accomplishment, determination, ambition	The product/service/system fosters healthy enthusiasm for doing something, commitment, devotion, wanting to achieve something, ambition (e.g., for extreme ambition, code “Accomplishment, determination, ambition [harmed]”)
Accomplishment, determination, ambition [harmed]	The product/service/system harms enthusiasm for doing something, commitment, devotion, wanting to achieve something, ambition; either because these abilities/capacities cannot develop or because they are used in an extreme form (e.g., being overly ambitious is not virtuous, too much commitment might lead to obsessions etc.)
Authenticity [harmed]	The product/service/system harms the person's authenticity, e.g., when users/customers have to “obey the system”
Caring (about things)	The product/service/system fosters people's caring for/taking care of things, e.g., by asking the couriers to take care of the food they deliver
Caring (about things) [harmed]	The product/service/system does not support people's caring for/taking care of things, e.g., bikers may take less care of food because of time pressure
Cleanliness/Hygiene	The product/service/system fosters a person's (the biker's) personal hygiene
Courage	The product/service fosters a person's courage, for example, to do something on one's own
Courage [harmed]	The product/service/system does not enhance the user’s/customer’s courage but rather their frightfulness
Diligence	The product/service/system fosters diligence, that is, investing effort in doing things well

Diligence [harmed]	The product/service/system undermines diligence, that is, investing in doing things well
Excellence	The product/service/system fosters excellence, that is, striving to do something or be something in the best possible way
Flexibility of the person	The product/service/system fosters the flexibility of a person, based on its own flexibility
Flexibility of the person [harmed]	Because of the product/service system, people might become less flexible, e.g., because of routine
Frugality	The product/service/system fosters the willingness not to waste resources
Frugality [harmed]	The product/service/system reduces the willingness to not waste resources and be content with less
Gratefulness, gratitude	The product/service/system fosters the gratitude of a person, e.g., a customer’s appreciation for receiving the ordered food
Gratefulness, gratitude [harmed]	The product/service/system reduces the gratitude of a person
Greed [neg.]	The product/service/system fosters greed, that is, excessive fear of losing something or wanting for more
Integrity	The product/service/system fosters a person's integrity, e.g., because of fair management decisions
Integrity [harmed]	The product/service/system harms a person's integrity, e.g., because of job loss, or loss of phone (and data)
Jealousy [neg.]	The product/service/system fosters jealousy or envy, that is, feelings that one does not want to share something with others, but rather wants to have something that others have
Laziness [neg.]	The product/service/system fosters being unoccupied, becoming inactive or lazy
Modesty, humbleness [harmed]	The product/service/system undermines or decreases the ability to be humble, modest, to not show off and be modest about one's achievements and possessions also: humility
Narrowmindedness [neg.]	The product/service/system supports people in becoming narrow-minded, e.g., because of obedience to an app
Obsession [neg.]	The product/service/system fosters obsessive behaviours or attitudes in the user
Openness	The product/service/system fosters openness in people, that is, the willingness to experience something new
Openness [harmed]	The product/service/system harms the desire to go outside and explore the world

Orderliness	The product/service/system fosters orderliness or cleanliness, that is, the ability to keep one's things and room tidy and in order
Orderliness [harmed]	The product/service/system harms orderliness or cleanliness, that is, the ability to keep one's things and room tidy and in order
Patience	The product/service/system fosters the ability to be patient or act patiently
Patience [harmed]	Because of the product/service/system, people are impatient/act impatiently or lose the ability to be patient or act patiently
Perseverance	The product/service/system fosters perseverance or persistence, that is, not giving up in spite of difficulties
Perseverance [harmed]	The product/service/system harms or decreases perseverance or persistence, that is, not giving up in spite of difficulties
Prudence [harmed]	The product/service/system undermines prudence, e.g., by discouraging people to undergo regular health checks
Punctuality	The product/service/system fosters punctuality, that is, being on time
Responsibility & reliability	The product/service makes the person act reliably/responsibly or feel responsible for his/her actions, duties and tasks and do them well
Responsibility & reliability [harmed]	The product/service makes the person act less reliably/responsibly or feel less responsible for his/her actions, duties and tasks
Reverence [harmed]	The product/service/system harms reverence, e.g., due to lack of affection and reduced human contact
Self-awareness	The product/service/system fosters self-awareness, e.g., by supporting the awareness of one's health and well-being
Self-care	The product/service/system fosters self-care, that is, looking after oneself
Self-interest [neg.]	The product/service/system fosters self-interest, that is, using things for one's own benefit
Selflessness [harmed]	The product/service/system reduces selflessness, that is, valuing others higher than oneself and acting for the benefit of others, e.g., sharing
Sense of justice	The product/service/system fosters a sense of justice, that is, the ability to discern what is wrong from what is right
Sense of justice [harmed]	The product/service/system harms the sense of justice, that is, the ability to discern what is wrong from what is right
Temperance, self-control [harmed]	The product/service/system harms temperance, that is, the ability to keep one's nerve and to restrain oneself, one's thoughts or one's feelings
Value class: Social-individual values	
Caring (about people)	The product/service/system fosters people's caring for others
Caring (about people) [harmed]	The product/service/system does not foster people's caring or concern for others or decreases/harms it

Commitment	The product/service/system fosters people's commitment or dedication, that is, feeling oneself connected to an object/agreement/person/company
Commitment [harmed]	The product/service/system does not support/harms people's commitment or dedication, e.g., because of a fixed salary, people might not be fully committed to their job
Considerateness	The product/service/system fosters a considerate, cautious, and careful attitude, e.g., thinking of other people or interests and reflecting these thoughts in one's own behaviour
Considerateness [harmed]	The product/service/system harms/does not support a considerate, cautious, and careful attitude or even leads to carelessness, e.g., not thinking of other people or interests or not reflecting these thoughts in one's own behaviour
Empathy, compassion	The product/service fosters empathy or compassion
Empathy, compassion [harmed]	The product/service leads to a loss of empathy or compassion, e.g., due to increased interaction with technology and decreased human contact
Forgiveness [harmed]	The product/service/system harms forgiveness, that is, the ability to forgive someone
Generosity	The product/service/system fosters generosity, e.g., when a manager is generous towards the employees
Generosity [harmed]	The product/service/system harms generosity, e.g., when the customers are not generous towards the courier
Helping others, helpfulness	The product/service supports helpfulness and helping others, and/or makes/lets people contribute to other people's happiness by providing a service to them, also referred to as “beneficence” or “altruism”
Helping others, helpfulness [harmed]	The product/service does not support helpfulness and helping others, also referred to as “beneficence” or “altruism”
Impartiality [harmed]	The product/service/system undermines impartiality, that is, forming one's opinion objectively and independently
Kindness/friendliness	The product/service supports friendliness, that people be kind/act kindly towards other people
Kindness/friendliness [harmed]	Because of the product/service/system, people are not as kind as before
Loyalty	The product/service/system increases the user's or customer's loyalty
Respect	The product/service/system fosters respect, i.e., appreciating or being appreciated by someone
Respect [harmed]	The product/service/system harms or endangers respect towards (other) human beings, i.e., appreciating or being appreciated by someone
Solidarity [harmed]	The product/service/system fosters solidarity, that is, feeling with other people and acting accordingly

Tactfulness	The product/service/system fosters tactfulness, that is, being considerate in a specific situation and acting accordingly
Tactfulness [harmed]	The product/service/system harms tactfulness, that is, being considerate in a specific situation and acting accordingly
Tolerance	The product/service/system fosters or increases tolerance, that is, acceptance of other people and the way they are
Tolerance [harmed]	The product/service/system endangers or reduces tolerance
Truthfulness, honesty	The product/service/system fosters honesty, sincerity, truthfulness, or ensures that one's promises are kept
Truthfulness, honesty [harmed]	The product/service/system harms or decreases honesty, sincerity, truthfulness, or results in one's promises being broken

6.3.1. Table D4. Personal characteristics or abilities

Category	Description of category
Awareness and attention	The product/service/system fosters the ability to concentrate/focus, increases awareness and attention, or decreases distraction(s)
Awareness and attention [harmed]	The product/service/system harms the ability to concentrate/focus, decreases awareness and attention, or leads to distraction
Creativity, imagination	The product/service/system fosters the ability to produce original and unusual ideas, or to make something new or imaginative
Creativity, imagination [harmed]	The product/service/system harms the ability to produce original and unusual ideas, or to make something new or imaginative
Curiosity	The product/service/system fosters curiosity
Curiosity [harmed]	The product/service/system harms/decreases curiosity
Emotional competencies	The product/service/system fosters the ability to share and express emotions
Emotional competencies [harmed]	The product/service/system undermines or harms the ability to share and express emotions
Good judgment	The product/service/system supports users' ability to make good and realistic judgments, e.g., about their state of health
Good judgment [harmed]	The product/service/system does not support users' ability to make good and realistic judgments, e.g., about dangers, or differentiating between humans, objects, and animals
Humour	The product/service/system fosters humour in people
Humour [harmed]	The product/service/system harms/decreases humour in people

Obedience [harmed]	The product/service fosters non-obedience or decreases obedience in people (i.e., not acting in accordance to rules and orders, not doing "what they are told", e.g., follow the path as provided by the navigation service)
Proactive behaviour	The product/service/system fosters proactive behaviour and an active attitude and personality, that is, wanting to do something, initiating something out of one's own motivation
Self-confidence	The product/service/system fosters (self-) confidence, self-esteem and self-respect, that is, positive feelings about oneself and one's achievements and competencies as well as the ability to stand by one's decisions or come up with confident explanations
Self-confidence [harmed]	The product/service/system harms/decreases (self-confidence), self-esteem and self-respect, that is, positive feelings about oneself and one's achievements and competencies as well as the ability to stand by one's decisions or come up with confident explanations
Spontaneity	The product/service/system fosters spontaneity, that is, the desire and ability to do something without having planned it for a long time
Conflict management abilities	The product/service/system fosters or supports the ability to manage difficult social situations or conflicts
Conflict management abilities [harmed]	The product/service/system harms the ability to manage difficult social situations or conflicts or prevents such an ability from developing
Social skills	The product/service/system supports or fosters social skills, which includes knowledge of how to build good relationships with people, how to best interact with people, how to understand people
Social skills [harmed]	The product/service/system does not support but rather harms social skills or leads to anti-social behaviour
Tech-savviness	The product/service/system fosters abilities and competencies to interact with technologies

Table D5. Emotions

Category	Description of category
Exhaustion, burnout [neg.]	The product/service/system leads to the experience of exhaustion or burnout symptoms, e.g., because of job demands
Feeling hope	The product/service/system supports the feeling of hope
Feeling joy	The product/service/system fosters joyfulness, that is, a joyful, happy attitude towards people and the world
Feeling lonely [neg., prevented]	The product/service/system prevents feelings of loneliness or solitude, e.g., by enabling the user (or other people) the company of other people
Feeling lonely [neg.]	The product/service/system causes feelings of loneliness or solitude, e.g., because the user (or other people) does not have the company of other people

Feeling powerless [neg.]	The product/service/system leads to feelings of powerlessness or self-doubt, e.g., due to constant control; lack of empowerment
Feeling proud	The product/service/system fosters feelings of pride, e.g., for having achieved something great
Feeling rejected [neg.]	The product/service/system causes feelings of rejection, e.g., between patients and doctors
Feeling safe	The product/service/system helps the user to feel safe and protected
Fun	The product/service/system increases fun, or it enables that that certain functions are enjoyed
Fun [harmed]	The product/service/system decreases/does not support fun
Passion, enthusiasm	The product/service/system fosters enthusiasm or passion, that is, highly positive feelings towards an object or action or while doing something
Passion, enthusiasm [harmed]	The product/service/system decreases or prevents enthusiasm or passion, that is, highly positive feelings towards an object or action or while doing something
Relaxation, calm	The product/service/system allows the user or customer to be calm, relaxed, peaceful, with fewer concerns, e.g., through good information and feedback, because parents do not need to worry about their child because it is monitored by a toy, or because the product/service/system creates a silent environment through fewer cars on the streets
Relaxation, calm [harmed]	The product/service/system harms the user or customer in that they cannot be/feel calm, relaxed, peaceful, or feel more concerned, e.g., because of a loud and noisy environment
Wonder	The product/service/system supports feelings of wonder, that is, a fascination for things in the world
Affection	The product/service/system fosters receiving affection from other people or feeling affection towards them
Affection [harmed]	The product/service/system harms or decreases affection, that is, receiving affection from other people or feeling affection towards other people

Table D6. Product characteristics

Category	Description of category
"Human-like personality"/ voice	The product is designed to have a human-like personality
Accounting system for salary	The system offers an accounting system, e.g., for calculation and payment of monthly income, performance-salary algorithm, or accurate payment

Adapts to new technologies	The system quickly adapts to or adopts new technologies, e.g., new sensors or updated OS
Advanced input/processing/ output	The product/system (1) can, on its own, communicate (e.g., through speakers or visual display) and interact (e.g., through gestures or movements) with the user or customer in an intelligent/advanced way (e.g., correct grammar); (2) it recognizes its surrounding, objects (feels touch), voices, emotions, speech as input for an action/interaction
Advertisements	The system shows/does not show advertisement
Automatic & Autonomous	The system executes some functions automatically, without the user or customer having to interfere (in that sense it is “independent” from humans/users), or is referred to as “autonomous”
Basic functionality	The basic functionality of the system is referred to, e.g., “server functionality”
Basic infrastructure to interact	The product or system can interact/communicate with the user, usually via speakers, microphone, camera, or chatbots (interaction human/machine; for communication between people, see “Enables communication”)
Battery durability	The product/system runs efficiently with low consumption of energy and good batteries, i.e., has a long battery life
Brand	The product/service/system entails building of a new brand
Compatibility, Connectivity	The product/system can be used on/connected to/accessed by different platforms (web, mobile, desktop, …), different operation systems (iOS, android, …) or different devices (tablet, PC, smartphone…)
Data analytics	The system collects information about the application or supports data analytics, predictive analytics, or pattern recognition
Database	The system supports databases, e.g., by collecting user data
Detect bad customers or employees	The system enables watching out for/taking actions against “bad customers” or employees
Emergency handling	The product/system has inbuilt functions (e.g., an alarm button) for cases of emergency when the user is in danger, e.g., in case of an accident
Enabling communication	The product or system enables communication between external parties (e.g., biker - customer), for example, through instant messaging, calls, or video chats (human-human interaction/communication)
Entertainment programme	The product or system offers a variety of entertaining programmes, for example, it can play videos/songs/music, tell stories
Fast processing/response	The system acts or reacts quickly or the processing (e.g., of data) is fast
Form factor	The physical product’s appearance (e.g., size, weight, materials) or add-ons (e.g., sensors) or the system's make-up (e.g., interface) is mentioned as a separate product characteristic

Health monitoring	The product/system measures different biometrical parameters such as the body temperature, heart rate and sleep pattern of its primary user
Information display	The product or system provides the customer/user with information on the state of a process (e.g., food order, but also about e.g., weather, earnings)
Maintenance: cleaning and charging	The maintenance of the physical product or system in terms of cleaning, washing, charging, etc., is described, e.g., "wireless charging", "washable", or "machine-washable"
External environment monitoring	The product/system measures different parameters such as room temperature and humidity in its environment by using sensors
Motion	The product is able to move around (on its own)
Navigation service	The system localizes the device and suggests a route, navigates and/or tracks the user, often using GPS; code here for "localization" and "tracking"
Notifications	The system notifies the user or related people (e.g., parents or customers), e.g., by sending a message or reminder in case of predefined conditions and circumstances (e.g., appointments)
Parental control	The system allows secondary users (e.g., parents) to control the product/service/system
Payment options	The product's/service's/system's payment options are mentioned, e.g., "digital"
Rating/review system	The system enables evaluation, displays evaluations of or feedback for a service or (human) performance, and/or gives recommendations (based on the evaluations)
Remembering and recalling	The product/system remembers users (and their preferences), e.g., it learns the child's name
Remote service	The product/service/system enables digital, online or remote services, including online prescriptions by the doctor (to be issued/sent), delivery (e.g., of medicine) or diagnoses by a doctor
Response to gestures	The system can be controlled via gestures
Reward system	The service or system allows good performances to be rewarded (e.g., by the company or the customers), for example, by rewarding customer loyalty
Robust physical design	The physical product is designed in a way that makes it robust, e.g., through long-lasting materials, shock-resistance, or waterproofness
Safety monitoring	The product/system surveils (or tracks) the user for his/her own safety
Scheduling function	The system supports the organization of shifts, jobs, appointments or consultations through the application
Search engine for information	The system allows searches for specific and relevant information, such as diseases for patients

Smart features	The system is referred to as “smart” (often combined with technologies such as AI)
Storage capacity	The system's size in terms of storage capacity is specified, e.g., its “weight” on the phone
Subscription plans	Specifics about how users are reachable and bound to the product/service are mentioned, e.g., mailing campaigns, subscription plans, service payment, reimbursements, try-out-periods etc.
Support service	Support service is offered to people using the product/system or service to help and support the user (also includes video tutorials)
Tracking and profiling	The system tracks or records orders, deliveries, workers/bikers, or monitors children's activities/movements, or creates profiles of employees, for example, to ensure product/service quality, e.g., by assessing/checking their reliability, loyalty, or their performance
Updates	The system is or can be updated (regularly)
User history	The system displays the user's history, e.g., their past earnings and statistics
Voice recognition	The system recognizes voices and can be controlled via voice commands

Appendix E Results of the Statistical Analyses (RQ2)

Table E1. Overview of statistical effects of IT products and approaches

Approach main effect	Technology roadmap vs. value-based approach			
Parameters	*df*	*F*	*p*	η^2
Fluency	1, 51	138.22***	< 0.001	0.73
Fluency, product ideas	1, 51	26.26***	< 0.001	0.34
Flexibility	1, 51	133.92***	< 0.001	0.72
Originality	1, 51	278.46***	< 0.001	0.85
Adverse effects	1, 51	263.88***	< 0.001	0.84
Stakeholders	1, 51	50.05***	< 0.001	0.50
Product main effect	Bike courier app vs. smart teddy bear vs. telemedicine system			
Parameters	*df*	*F*	*p*	η^2
Fluency	2, 51	2.76 (n.s.)	0.073	0.10
Fluency, product ideas	2, 51	15.65***	< 0.001	0.38
Flexibility	2, 51	2.94 (n.s.)	0.062	0.10
Originality	2, 51	4.56*	0.015	0.15
Adverse effects	2, 51	0.03 (n.s.)	0.980	< 0.01
Stakeholders	2, 51	6.81**	0.002	0.21
Approach * product interaction				
Parameters	*df*	*F*	*P*	η^2
Fluency	2, 51	1.29 (n.s.)	0.284	0.05
Fluency, product ideas	2, 51	7.52**	0.001	0.23
Flexibility	2, 51	0.91 (n.s.)	0.409	0.03
Originality	2, 51	3.31*	0.044	0.12
Adverse effects	2, 51	0.03 (n.s.)	0.976	< 0.01
Stakeholders	2, 51	7.91**	0.001	0.24

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

Appendix F Detailed Results for Each Investigated Technology

Figure F1. Instrumental/intrinsic values and virtues among value ideas for bike courier app

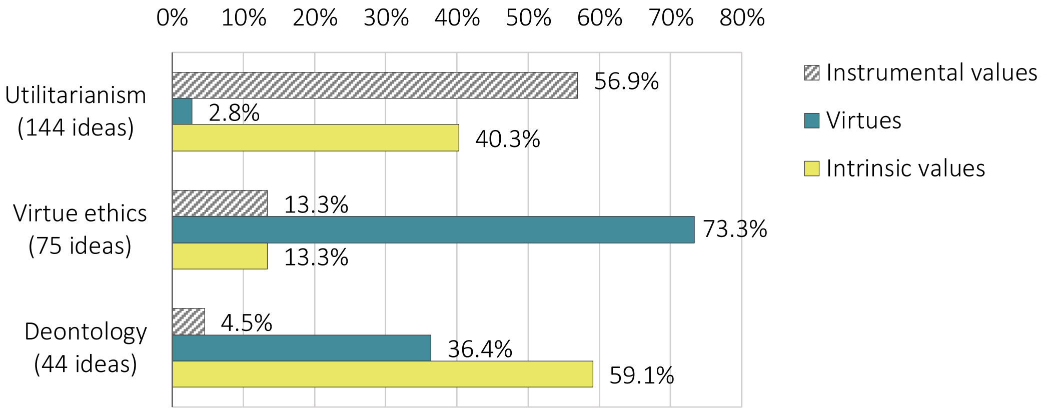


Figure F2. Instrumental/intrinsic values and virtues among value ideas for smarty teddy bear

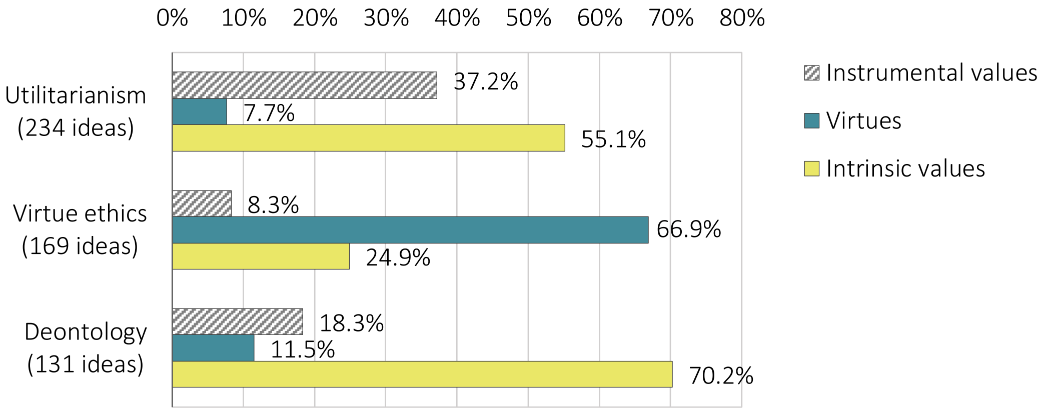


Figure F3. Instrumental/intrinsic values and virtues among value ideas for telemedicine platform

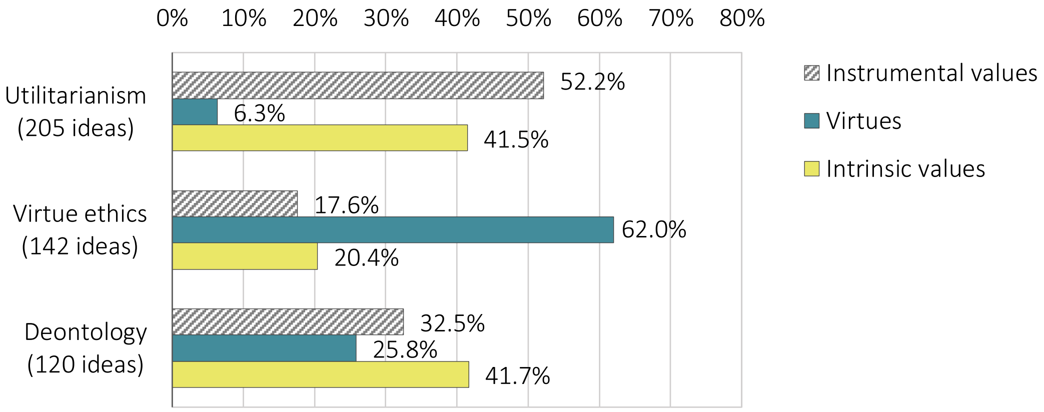


Figure F4. Sustainability dimensions underlying value ideas for bike courier app

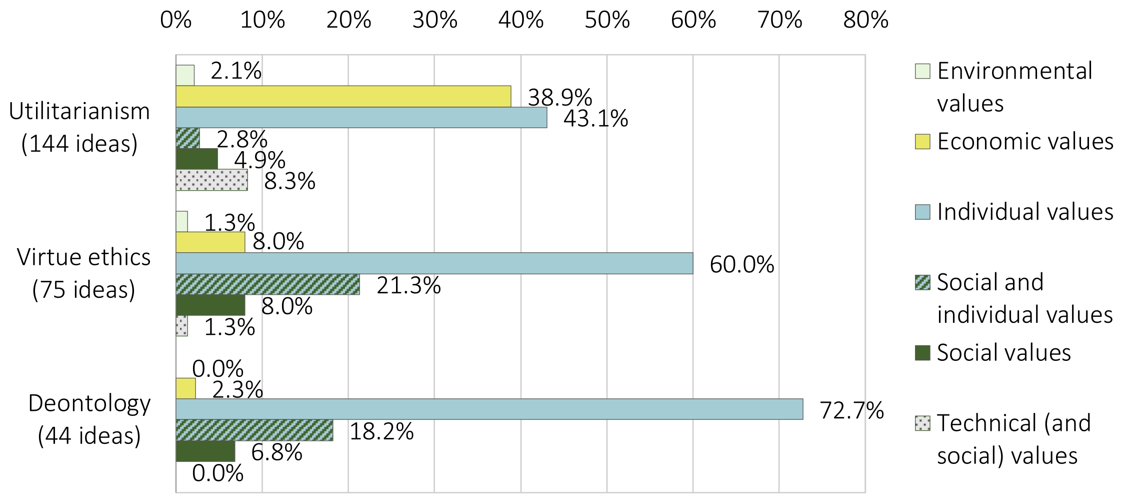


Figure F5. Sustainability dimensions underlying value ideas for smart teddy bear

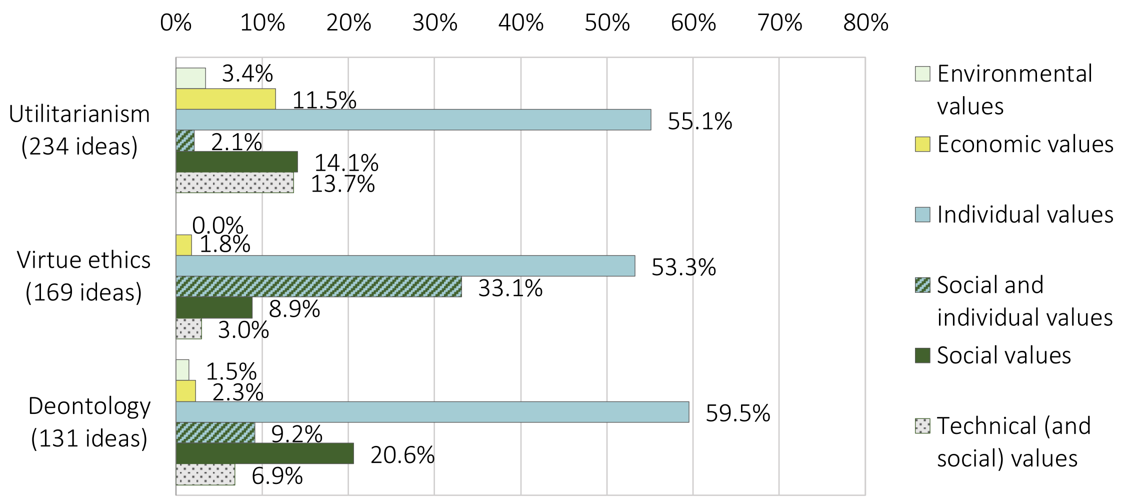


Figure F6. Sustainability dimensions underlying value ideas for telemedicine platform