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Eliciting Values for Technology Design with Moral Philosophy: An Empirical Exploration of Effects and Shortcomings

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Abstract:	Calls for an ethically aligned technology design have led companies to publish lists of value principles that their engineers should adhere to. However, it is questionable whether such lists can grasp a technology's wide-ranging ethical implications. The bottom-up elicitation of values from the specific technology context avoids problems that predefined lists of values have, but has been criticized for lacking an ethical foundation. In this empirical study, we explore how the grand ethical theories of Western philosophy—utilitarianism, virtue ethics and deontology—can support the discovery of values. Based on three technological products, our results show that philosophically grounded perspectives can support IT professionals in identifying values that are not only context-specific, but also cater to higher ethical principles (i.e., intrinsic values) and a broad spectrum of sustainability goals (e.g., economic, technical, individual, etc.). Each theory of ethics served a unique role in the identification of ethical issues and value potentials of a technology. However, results also suggest an overrepresentation of current mainstream values and individual values while social environmental issues were neglected. We conclude that theories of ethics encourage different perspectives on a specific technology and thus argue for a pluralist ethical grounding for values in technology design.

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Introduction

With new technologies reaching into sensitive areas such as our privacy, the call for an ethically aligned technology design is more topical than ever. 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). Technology mediates how we experience the world and influences how we make moral decisions (Verbeek 2006). Interfaces can be purposefully designed to bring about specific human behavior, such as voting or addictive use. Most importantly, scholars have observed that "we make things which in turn make us" (Ihde and Malafouris 2019, 196): Constant interaction with technologies impacts our conduct and our virtues. All this makes technology design inter alia a moral activity (Johnson 2015; Verbeek 2006). Thus, designers and engineers are requested to consider the ethical implications of the technologies they develop and proactively address them (Martin, Shilton, and Smith 2019).

But how can values be considered in practice? 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 their engineers should adhere to (Jobin, Ienca, and Vayena 2019). These lists promote an organization's commitment to protect relevant values such as digital privacy, transparency, absence from algorithmic bias, etc. However, it is questionable whether predefined value sets can indeed lead to a sustainable technology design and grasp the wide range of moral implications a technology might have. Innovation teams and engineers are no longer seen as providing only technical or economic value to society, but also human, social and environmental value (Penzenstadler and Femmer 2013). When pre-configured value lists are used, they project values onto empirical cases by applying the logic of the list to the problem at hand (Le Dantec, Poole, and Wyche 2009). This inadvertently leads to a limited view on the value spectrum affected by a technology. Also, the moral foundation of pre-defined value lists has been questioned (Mittelstadt 2019).

To avoid these limitations, scholars have argued for the bottom-up elicitation of values from the specific technology context (Le Dantec, Poole, and Wyche 2009; Reijers and Gordijn 2019). Value sensitive design (VSD; Friedman and Hendry 2019) is the most prominent approach in this regard. Yet VSD methods have been criticized for lacking an ethical foundation (Manders-Huits 2011; Jacobs and Huldtgren 2018). Reijers and Gordijn (2019) have argued that only proper ethical reflection can ensure that the value elicitation process identifies values of moral relevance and not just arbitrary stakeholder preferences.

In this paper, we want to explore whether normative ethical theories can contribute an ethical foundation to the value elicitation phase. More concretely, we explore how the grand ethical theories of Western philosophy—utilitarianism, virtue ethics and deontology—can support the discovery of values in technology design. Based on three different technological products, we investigate whether

value elicitation with the help of philosophically grounded perspectives is able to identify values that are not only context-specific, but also pertain to higher ethical principles (i.e., intrinsic values) and support a broad spectrum of sustainability goals (e.g., individual, social, environmental, etc.). Moreover, we compare how the unique reasoning of each ethical perspective leads to the identification of theory-specific value ideas.

Our paper is structured as follows. First, we critically reflect on the current top-down and bottom-up approaches to values in technology design. Then, we briefly review utilitarianism, deontology, and virtue ethics, examining how their core philosophical perspectives can contribute to the value elicitation process as well as discussing the critical arguments with which each theory has been met. In the empirical part, we present insights from our study, in which 71 young IT professionals in training applied the three ethical perspectives to the early technology design phases of one real-world and two fictitious technologies. We discuss the effects of employing normative theories in the value elicitation process along with the implications for current value-oriented design approaches. Our aim is to contribute an empirically founded argument for systematically eliciting values in technology design with the help of moral philosophy.

Values and Ethics in Technology Design

Triggered by dark AI scenarios and a detrimental amount of data protection and security breaches, investors have become sensitive to the many value harms and uncertainties that a technological innovation can create (Jobin, Ienca, and Vayena 2019). Designers have an ethical obligation to protect and enhance the welfare not only of direct users, but also of the public and the environment (Russ 2019). Ideally, their 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* (i.e., natural resources) values (Penzenstadler and Femmer 2013; Winkler and Spiekermann 2019). Value ethics, when applied to a technology domain, sees value harms when a plane is not safe, a car engine is not environmentally friendly or a social network is manipulative. Furthermore, it extends the discourse to positive value potentials, such as an algorithm's transparency or a robot's politeness.

Values represent what matters to humans, what they strive for and seek to protect, and as such have a moral connotation (Fuchs 2020). They can be defined as "conceptions … of the desirable" that influence human choices (Kluckhohn 1962, 395) or as principles of the "ought-to-be" (Hartmann 1932). In the context of ethical technology design, it is especially noteworthy that values can help to capture an aspiration for a greater good, such as sustainability goals (Penzenstadler and Femmer 2013; Winkler and Spiekermann 2019). For example, the recyclability of a computer fabric can contribute to the environmental friendliness of a device. Values can hence capture what is good *instrumentally* to achieve what is good *intrinsically*, i.e., good and valuable in itself (Hartmann 1932; van de Poel 2009; Scheler 1913-1916/1973; Spiekermann 2016). An intrinsic value such as "environmental friendliness" or "health" is a "good in itself, and not because it is a means to another end or contributes to another value" (van de Poel 2009, 975). Instrumental values in the technology context, such as ease of use or transparency are, in contrast, "a means to achieving a good end, i.e., another positive value" (p. 976).

Intrinsic values are "higher" in that they are experienced as deeper, more durable and fulfilling, and do not depend on other values (Scheler 1913-1916/1973).

A third group of human values inherent in the good character and conduct of a person are virtues. 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, 64). Examples are honesty, courage, loyalty, or humbleness. 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 a technology, which philosophers (Ihde and Malafouris 2019; Verbeek 2006) have pointed out. Thus, an ethical technology design framework should be able to capture not only values but also virtues.

The List-based Approach to Values

Ethical principle lists take value priorities published by corporate, political or industry representatives and apply them top-down to a technology context. Jobin, Ienca, and Vayena (2019) identified 84 policy documents in the field of AI alone, reaching consensus on 11 shared values: transparency, justice and fairness, non-maleficence, responsibility, privacy, beneficence, freedom and autonomy, trust, sustainability, dignity, and solidarity. While the increasing prominence of ethical guidelines is certainly desirable, applying values in a top-down manner is problematic in at least three ways.

First, published guidelines predominantly focus on preventing value harms, i.e., avoiding negative consequences. They tend to neglect the potential inherent in the active promotion of positive values (Jobin, Ienca, and Vayena 2019). However, values do not only set constraints on design but can help to uncover creative technological solutions (Shilton 2013) and foster new forms of added value for companies (Spiekermann 2016). Second, any predefined list risks a narrow focus on values that are being promoted through the list. This is especially problematic as IT development usually focuses on technical and economic values such as efficiency and ease of use, while values with social and environmental impact are being neglected (Lago et al. 2015). A truly ethical perspective should aim for a broadly sustainable technology design that acknowledges values relevant for technical, but also individual, social, economic and environmental development (Penzenstadler and Femmer 2013; Winkler and Spiekermann 2019), e.g., the protection of human dignity and health or the preservation of natural resources. Third, the consideration of broadly established values can lead to the neglect of values that are relevant for the specific technology context and the stakeholders that are affected by the technology, which should be the actual focus of design (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). To avoid the practical danger of projecting values top-down onto empirical cases, scholars have stressed that values should be discovered empirically (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 values "at the margins" (Agre 1997).

Bottom-up Value Discovery: In Need of Ethical Reflection Methods

VSD methods (Friedman and Hendry 2019) explicitly support the bottom-up elicitation of values through the identification of potential harms and benefits and the inclusion of stakeholders in the design process. Thus, they can avoid the problems with which predefined lists of values are confronted. Still, some scholars have leveled the criticism that VSD cannot distinguish relevant moral values from mere stakeholder preferences, and that it would benefit from an additional theoretical framework (Manders-Huits 2011; Reijers and Gordijn 2019). To ensure that a value elicitation process actually leads to the identification of higher, morally relevant values, a moment of ethical reflection and commitment (Shiell, Hawe, and Seymour 1997; Reijers and Gordijn 2019; Jacobs and Huldtgren 2018) or "philosophical mode" (Flanagan, Howe, and Nissenbaum 2008) is needed.

We investigate in this paper whether the three big normative theories of ethics—utilitarianism, deontology, and virtue ethics—can provide the missing ethical foundation for the value elicitation process. Friedman and Hendry (2019) have emphasized that VSD is open to *any* ethical theory, leaving it up to the people involved in the design process to determine what makes a value "moral." In this paper, we explore whether there are specific advantages and challenges that the philosophical perspective of one or the other ethical theory bears for the value elicitation process. After all, utilitarianism, virtue ethics, and deontology differ significantly in the way they derive what is good and right. Still, their unique approaches could produce complementary ideas on how human values are impacted by technology.

Utilitarianism: Weighing Beneficial and Harmful Consequences

Fields of study focusing on technology research and reflection, such as technology assessment, ethics of science and technology, or 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, 140). With this focus on implications and results they essentially follow a consequentialist approach when assessing technologies (Grunwald 2017). *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). In so doing, they provided a strong reasoning for the evaluation of what is morally right as well as the philosophical origin of two basic concepts of neoclassical economics. The *analysis of costs and benefits* suggests weighing the expected costs of a decision, project, or product against the expected resulting monetary value, while the *maximization principle* mandates choosing the action that is expected to result in the highest positive value. VSD projects often follow a similar approach by identifying potential stakeholder harms and benefits and mapping them onto corresponding values (Friedman, Hendry, and Borning 2017). However, the emphasis of possible consequences, e.g., the implications of a technological capability, also raises issues.

First and foremost, it can lead to the justification of actions that cause harms. An example for where this becomes relevant in technology design is the Moral Machine experiment[1] 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 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. James H. Moor (1999, 68) argued that "good ends somehow blind us to the injustice of the means." This can be mitigated by a form of "general utilitarianism," which does not focus only on the consequences of one particular action (as is the case for "act utilitarianism"), but also considers what the consequences would be if *everyone* were to act likewise in a specific situation (Frankena 1973).

Deontology: Addressing Moral Obligations

While consequentialist theories such as utilitarianism focus on the *consequences* of an act, deontological theories put the emphasis on *duty*, as *deon*, the Greek word for duty, implies. From a deontological perspective, a moral agent has to consider the universal laws inherent in an action. Kant formulated this in the first part of his categorical imperative: "act only according to that maxim by which you can at the same time will that it should become a universal law"—and added that the outcome of an action can never justify the action itself (Kant 1785/2011). Duties in the form of rules have a long tradition in many societies, and even form a common instrument of moral guidance in the corporate context, e.g., in the form of professionals' codes of ethics, such as the "ACM Code of Ethics and Professional Conduct" (2018).

However, the deontological focus on universal principles can be difficult to apply to concrete situations. Also, deontology faces a difficulty in the tension between alternative moral duties that seem equally important but lead to different behavioral outcomes. Ironically, deontological theories can deal with these issues by incorporating consequentialist elements; for example, the duty to emphasize actions that "promote the aggregate good" (Ross 1930). In this way, deontology and utilitarianism can complement each other (Brady and Dunn 1995). 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, not considering how such a principle would play out if everyone applied it as a general law. In the current business and technology environment, principles such as profit, innovation, or growth could be mistakenly considered 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. When combining the perspective of deontology on values with other ethical theories, it seems plausible to conduct the deontological analysis last in order. Ideally, it will re-

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

evaluate previously identified values and virtues and emphasize those that deserve the greatest attention in the design process instead of overemphasizing central value themes.

Virtue Ethics: Supporting Good Character Traits

Virtue ethics is one of the oldest and most prominent theories that emphasizes the moral excellence of a person's character rather than her adherence to rules of action, duties, or resulting consequences. A virtuous person will tell the truth, not because she has to or because it leads to the best outcomes, but because she *is* a truly honest person and wants to lead a morally good life. According to classical virtue ethics, represented especially by Aristotle (384–334 BC*;* 2004), only a really virtuous person will live in true happiness or *eudaimonia*. Virtues are bound to the character and behavior of individuals, but at the same time bear relevance to the moral thriving of a community at large. 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, 27). Thus, virtues can help to emphasize the importance of society and social practices instead of only focusing on the individual in moral questions (MacIntyre 2007). While virtue ethics played a subordinate role in modernity, it has recently shown great potential in dealing with the ethical issues posed by new technological developments. Among the most important proponents of virtue ethics today is Shannon Vallor (2016), who presented a set of technomoral virtues including honesty, self-control, and empathy, which she sees as particularly important for dealing with the "increasing global complexity, instability, plurality, interdependence, rapid change, and growing opacity of our technosocial future" (p. 245). While these virtues are universally important, Vallor has also presented a more context-specific virtue-ethical analysis of friendship on new social media (Vallor 2012).

A virtue ethical perspective seems important for a wise management of the technoscientific power in our society. Focusing on the concept of virtue in the design process can support business people and engineers to consider the moral development of affected stakeholders, who they might otherwise only see as "user," "human resource" or "consumer." This aspect has come more to the forefront of critical technology discussion, and the concern about the degradation and symbolic impoverishment of humanity (Stiegler 2019). However, virtue ethics has also been criticized, as it does not offer straightforward guidance on morally good actions, e.g., through moral guidelines or universal principles. By contrast, virtue ethicists such as Vallor (2016) would argue that this apparent weak point of virtue ethics is actually 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 not easily able to do. Thus, virtue ethics might be especially suited to complementing a bottom-up elicitation process of values and virtues relevant for a specific technology.

Empirical Study on Ethical Theories in the Value Elicitation Process

Over the course of two semesters, 71 young IT professionals enrolled as students in a master program in Information Systems participated in an empirical study that analyzed one of three innovative digital technologies: a bike courier service, a smart teddy bear or a telemedicine platform. The goal was to

explore how the practical application of the core philosophical reasoning of three ethical theories (utilitarianism, virtue ethics and deontology) could guide the value elicitation process.

In the first semester, 36 participants (age: M = 23.9, SD = 2.6; 47.2% female; 21 different nationalities) were split into two groups and worked individually either on the product scenario of a smart teddy bear dedicated to the entertainment of children (n = 24) or on a bike courier app for bikers who receive food orders they deliver to households (n = 12). In the following semester, 35 participants (age: M = 24.6, SD = 2.6; 38.2% female; 14 different nationalities) worked in pairs and analyzed a real-world telemedicine platform that connects doctors to patients through an online video interface to make a first diagnosis and then refer them to specialists from the platform's own recommender database, which benchmarks specialists' performance and doctoral qualities. All study participants had considerable training in both business management and engineering due to the master program's admission criteria and substantial professional experience[2].

While the bike courier service and the smart teddy were fictitious cases that only resembled existing services, the telemedicine platform was a real-world case conducted in cooperation with a local start-up. All students received introductory courses on utilitarianism, virtue ethics, and deontology and how to use their underlying philosophical reasoning for bottom-up value identification. They then applied all three ethical perspectives to one of the three technologies to identify values that the respective technology should cater to and protect. Guided by the core reasoning of the ethical theories, participants described harms or benefits, personal character implications or relevant personal maxims and named the value that they saw impacted. Table 1 shows the questions that summarize the central idea of every ethical perspective used to guide participants in their ethical analyses and the type of data we retrieved to conduct the analyses presented below. All in all, the questions led the 71 participants to describe 1,471 positive and negative implications related to the introduction of the three technologies.

Table 1. Questions guiding the ethical analyses of the respective technology and resulting data

	Question	Resulting data
1. Utilitarianism	What are all the thinkable consequences you can envision from the widespread use of the technology for direct and indirect stakeholders?	• Potential benefits or harms • Related value(s)
2. Virtue ethics	What are the implications of the technology for the character and/or personality of direct and indirect stakeholders—that is, which virtues or vices could result from the widespread use of the technology?	• Potential character benefits or harms • Related virtue(s)
3. Deontology	Which of your personal maxims that you would want to be recognized as a universal law do you see fostered or harmed by the widespread use of the technology?	• Maxims potentially fostered or harmed • Related value(s)

[2] 74% of master students registered at public universities in Austria are known to work at least 20 hours in parallel to their studies (Unger et al. 2020).

In a bottom-up and iterative coding process (described in detail elsewhere, see anonymized paper submitted as Supplementary File for the review process), two coders analyzed the 1,471 ideas and discerned five categories to structure them: intrinsic values (e.g., "equality"), instrumental values (e.g., "ease of use"), virtues (e.g., "truthfulness"), emotions (e.g., "feeling lonely"), and personal characteristics/abilities (e.g., "tech-savviness"). Below we focus on the 1,264 ideas that relate to values or virtues. For these we also determined the underlying *sustainability dimension*, guided by a theoretical framework that connects five dimensions of sustainability (individual, social, technical, economic, environmental; Penzenstadler and Femmer, 2013) to values (Winkler and Spiekermann 2019). Our final category system included a total of 113 values, which consisted of 41 instrumental and 25 intrinsic values as well as 47 virtues (see Supplementary File for details).

Comparison of Elicited Values Across Ethical Perspectives

The pool of frequently elicited values showed a high sensitivity for the respective technology context, with very few overlaps across the three technologies. Still, "central" (Agre 1997) or "mainstream" values (Spiekermann 2016) such as "knowledge," "privacy" or "health" reoccurred frequently across all technologies and ethical theories. Table A2 in the appendix contains the details on frequent values found for each technology and ethical theory.

Utilitarianism triggered by far the greatest number of value *ideas* (N=583; compared to 386 ideas in the virtue ethical and 295 ideas in the deontological analysis). This is not surprising, as the utilitarian calculus invites us to consider as many value effects as possible for a valid weighing of harms and benefits. A comparison of actually identified *values* and *virtues* shows that the three ethical theories elicited a comparable amount (utilitarianism: 78, virtue ethics: 79, deontology: 74). Still, the theories differ in the type of values they emphasize. Utilitarianism seems particularly prone to emphasizing mainstream values such as "health," "privacy" and "productivity/profit," which were mentioned in the utilitarian analysis of all three technologies by at least one third of the participants. This leads us to speculate whether the value ideas raised by utilitarianism are perhaps raised based on their prominence in the current discourse, rather than on a critically reflected ethical reasoning.

In the deontological analysis, which was the final analysis to be conducted, participants frequently re-embraced mainstream values discovered in the utilitarian analysis. For example, more than half of the participants mentioned "privacy" in the three technology analyses. Value elicitation with deontology thus runs the risk of promoting duties mechanically by repeating values that everyone talks about (e.g., in the press), but not "out of duty," as Kant himself would have wanted it (Kant 1785/2011). That said, the deontological analysis also regularly led participants to identify high intrinsic values not often mentioned in any of the other two ethical analyses, such as "freedom," "equality" or a fear of losing "human contact."

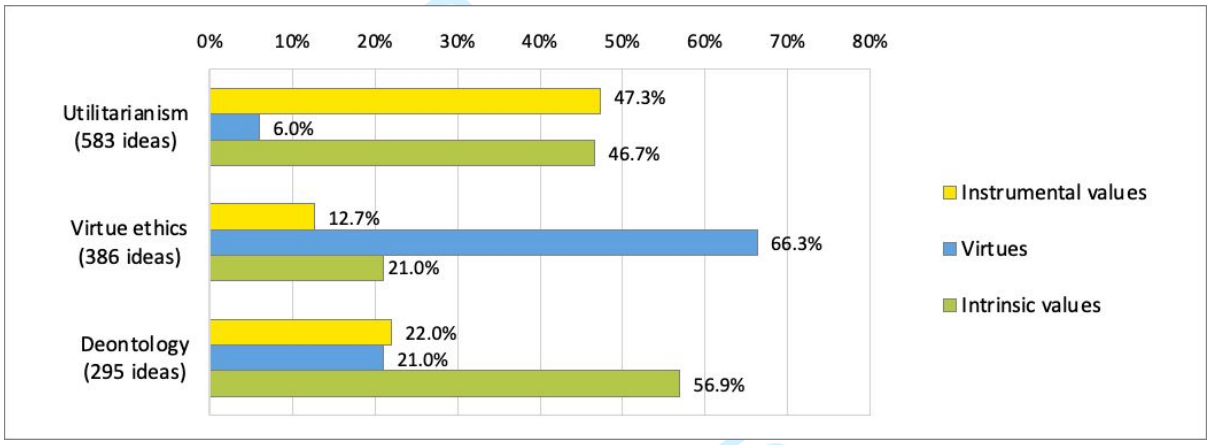
Virtue ethics unveiled fewer mainstream values, probably because a technology's character effects are rarely discussed in today's public technology discourse. Virtues that at least half of the participants mentioned were the "reliability" of bike couriers, which can be fostered through the constant usage of a time-sensitive app, the "kindness" of children, which might be promoted through the smart teddy bear's polite form of conversation, and the "commitment" of patients to their personal healthcare, which

is supported by a telemedicine platform that is easier to consult than a physical practice. The virtue ethical analysis also inspired more nuanced virtue reflections on the bike courier's potential loss of a "healthy ambition" because of a lack of human interaction, the child's loss of "courage" due to the ubiquitous presence of its digital companion or the doctor's increased "considerateness" due to extended video sessions with patients.

Elicited Intrinsic Values, Instrumental Values and Virtues

Participants successfully came up with a variety of ideas related to instrumental values, intrinsic values and virtues. In line with the philosophical reasoning behind each of the ethical perspectives, the three category groups show significant variations in their prominence for utilitarianism, virtue ethics and deontology. Figure 1 shows an overview on the pool of ideas aggregated for the three technologies (see Figure A1 in the appendix for detailed results for every technology separately).

Figure 1. Share of instrumental/intrinsic values and virtues among the pool of value ideas aggregated for the three technologies



Utilitarianism clearly elicited the greatest share of instrumental values (47.3%). This relates well to the general utilitarian reasoning, where values such as "efficiency" and "productivity" cater to the utilitarian good. That said, Figure 1 shows that utilitarian reflections also led to the identification of many intrinsic value ideas (46.7%). We explain this finding as being due to our study set-up, which invited participants to consider what the consequences would be if *everyone* were to act likewise in a specific situation instead of directing participants to focus only on *their* action in a specific situation (act utilitarianism) or on *rules* (rule utilitarianism). This might have inspired 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, contentment," which was mentioned most often in the utilitarian analysis.

Still, deontological reflections elicited the highest share of intrinsic value ideas (56.9%), which is in agreement with the deontological focus on universal principles. Participants came up with 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 more infrequent values such as the "development of society" in the telemedicine case. This shows that the deontological focus inspired participants to think about values of higher rank and hence potentially universal applicability in the value elicitation process. However, neither deontological nor utilitarian reasoning are able to unveil the true spectrum of a technology's implications for human character or virtuousness.

Virtue ethics naturally inspired participants to come up with ideas linked to virtues (66.3%). A total of 44 out of the 47 identified virtues (93.6%) were uncovered by the virtue ethical analysis (ranging from 80.8% to 100% for the three technologies). Participants' reflections described both how stakeholders' virtuous character traits and behaviors could be *affected by* the technology (consider, e.g., the bike courier's increased "flexibility" and "punctuality" due to the use of an app) and how virtues could *affect* how the technology plays out in a certain context (consider, e.g., a doctor's "commitment," "patience," or "excellence" when using the telemedicine platform). Furthermore, 21.0% of the ideas uncovered by the virtue ethical perspective related to intrinsic values important for individuals, such as "trust," "knowledge, education," or "independence."

Sustainability Dimensions Addressed by the Values Elicited

The pool of value ideas aggregated for all three technologies and categorized according to their underlying sustainability dimension (Figure 2) shows that in all three ethical perspectives around half (49.1–55.6%) of the value ideas centered on *individual* values, that is, values (e.g., "convenience" or "health") and virtues (e.g., "frugality" or "perseverance") that are catering to an individual's well-being. Compared to the identified *social* values, which together only covered 10.5% of ideas, this seems to hint at an overall bias towards individual development and well-being, and a neglect of societal development, social welfare and mutual care. "Health," "privacy," "knowledge," "satisfaction," "safety" and "independence," which cover almost half (49.1%) of all individual value ideas, surely represent intrinsic values that have a warranted moral relevance. Still, it is remarkable that participants' ideas related to individual values almost *five times* as often as to social values. This finding resonates with MacIntyre's criticism of individualistic moral thinking in modern societies.

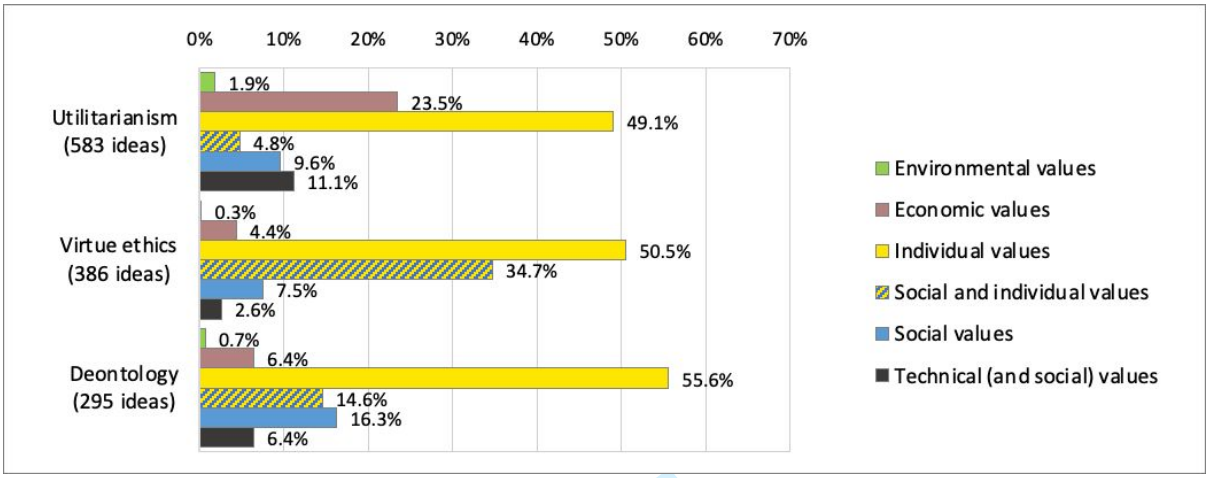
MacIntyre (2007) heavily criticized the predominant focus on the individual in moral questions, arguing that we should draw on classic moral philosophy to correct this flawed understanding and rediscover the importance of society and social practices. In contrast to MacIntyre's assumption, the virtue ethical perspective applied in this study did not make a notable difference: Participants identified 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").

A second important finding of our study 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 when bikes instead of cars conducted the food deliveries. This is a meager result in times of abounding environmental discussions. Participants could have thought about the waste created when analog products are digitalized as in the case of the smart teddy bear, or the CO_2 emissions caused by AI implementations. It could be 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 (Russ 2019). This result is critical, as it suggests that a combination of three ethical theories can still fail to see the most pressing value issue in a technology assessment study, the exhaustion and destruction of natural resources.

Finally, the other three sustainability dimensions, i.e., social, economic, and technical values, and their overlaps seem to reveal theoretically reasonable tendencies for each of the ethical perspectives. See Figure 2 for an overview on the pool of ideas aggregated for the three technologies and Figure A2 in the appendix for detailed results for every technology separately.

Figure 2. Underlying sustainability dimensions in the pool of value ideas aggregated for all three technologies



Utilitarianism was best at representing *economic* and *technical* values. The entanglement of utilitarian theories with economic history and concepts such as "maximizing utility" could explain why participants often thought of how the company could increase its "productivity," "efficiency" and "reputation" with the technology assessed. Among the technical value ideas, "IT security" came up most often. Participants also mentioned values that span the *technical* and *social* dimension, such as the "accessibility" of the telemedicine platform for elderly and handicapped users. That said, utilitarianism also covered *social* values. For example, participants identified a potentially negative value implication of the bike courier app on "human contact," or the smart teddy bear on the "child-parent relationship." To summarize, utilitarianism led not only to the highest number of ideas, but also to a diverse value spectrum.

Virtue ethics was best at eliciting values that have an *individual* and at the same time *social* relevance. This fits with the Aristotelian view that virtues are bound to an individual but are still worthy for the community. For example, a person who is kind or honest can neither develop nor express the underlying virtue without a social environment. Participants mentioned the bike couriers' "kindness/friendliness," children learning to "care" for both the smart teddy bear as well as for other people, but also thought of the telemedicine doctors' "truthfulness/honesty" and "empathy/compassion" towards patients. Still, most of the ideas (50.5%) related to the *individual* development of affected stakeholders, often described in virtues such as "patience" or "excellence." This shows that the virtue ethical perspective clearly inspired participants to focus on the development of individuals, a

perspective that is largely missing in the utilitarian analysis. However, as discussed above, participants did not sufficiently reflect on how this individual dimension plays out in the social context.

Deontology inspired participants to re-emphasize previously mentioned *technical* (e.g., "IT security") and *economic* values (e.g., "efficiency & optimization") as personal maxims. For the bike courier app, participants emphasized the individual value "privacy." Again, the emphasis of these values could be interpreted as empirical support of Hannah Arendt's critique that contemporary norms and principles are often misinterpreted as Kantian principles, which ignores the reciprocity and universality that the categorical imperative is based on. Still, we also see that deontology gives by far the most weight to *social* values compared to the other two ethical perspectives in the telemedicine platform, emphasizing "equality" and "fairness," or in the case of the smart teddy bear, emphasizing "friendship" and "love." While we only observe this tendentially, the underlying shift to socially relevant values inspired by an ethical perspective that emphasizes moral duty is noteworthy.

Implications for Value-oriented Research and Technology Design

Value Elicitation from Context Versus List-based Approaches

Our results show that an ethically grounded value elicitation process can help to identify various values that are underrepresented in value lists. First, the perspectives of utilitarianism, virtue ethics, and deontology inspired participants to identify a variety of values that took the specific context and the affected stakeholders of each technology into account. Second, they helped to elicit relevant instrumental values, intrinsic values and virtues. Third, the identified values were relevant for areas of sustainability that go beyond the technical or economic dimension, although they neglected especially the environmental dimension, which was conspicuous by its almost complete absence.

Above we discussed the dangers inherent in the use of preconfigured value lists. We introduced the meta-review of Jobin, Ienca, and Vayena (2019), who identified 11 shared value themes in 84 reviewed policy documents. Table A1 in the appendix shows the comparison of value codes that were included in the value themes by Jobin et al. and compares them to value codes from the present study. A direct comparison shows that the bottom-up capturing of values with ethical theories that we tested covered all of the 11 value themes for every technology, 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. Still, the rich spectrum of values that our participants discovered for every technology goes far beyond the themes mentioned in the list. This shows how much more there is to discover beyond the mainstream values that are overrepresented in the media or currently promoted by institutions.

A Pluralist Ethical Foundation for the Value Elicitation Process

Our findings suggest that utilitarianism offers a powerful approach to inspiring a high number of value ideas for a specific context and covers various value dimensions, although it does not consider the impact on the moral development of individuals within their social environment. Utilitarianism was also especially prone to emphasizing current mainstream values. Our results show that virtue ethics crucially complemented the utilitarian focus by emphasizing individual growth and personal

development, acknowledging the intersection of individual and social values. 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 and Gordijn 2019). Thus, the integration of a virtue ethical perspective in value-oriented research seems warranted, although we have pointed out an overall individualistic bias. We have shown that deontology, too, adds a unique ethical perspective. Deontology inspired most of the ideas that capture high intrinsic values with broad social import, such as "equality" or "freedom," which were neglected by the other ethical perspectives. Taken together, we clearly see evidence for combining the ethical perspectives for a pluralist ethical basis for the value elicitation process. In this way our findings support previous claims that an ethically grounded approach to values in technology needs a moment of ethical reflection, and should not be constrained through the use of value lists.

Two limitations of the empirical study design should be noted. First, our combined application of utilitarianism, deontology, and virtue ethics in the value elicitation process can only represent a selected and thus limited understanding of what is often referred to as the three big ethical theories of the Western canon. It leaves out other or more specific versions of these three ethical theories as well as alternative philosophical and cultural approaches to ethics, such as Confucianism, Buddhism, etc. To complement our results, we motivate future empirical research to investigate different versions of consequentialist, deontological, and virtue ethical theories and compare them to other theories of ethics as well. Second, we have investigated how different ethical theories inspire young IT professionals enrolled in university courses to identify relevant values. We don't know what these results would look like for senior IT professionals or other samples (e.g., ethicists, IT philosophers, engineers). While we have discovered a heavy focus on individual values across all three ethical analyses, future research could look into whether the same value elicitation exercise generates different results when conducted with samples from a collectivist culture or using another philosophical perspective.

Conclusion

In this paper, we argue that every theory of ethics contributes a unique asset to the discussion of what is right and wrong in technology design. We investigate three normative theories and their potential to support an ethically grounded value elicitation process. Our results show that the perspectives of utilitarianism, virtue ethics, and deontology lead to the identification of a broad variety of context-specific values that cater to various sustainability dimensions and go far beyond the value themes listed today by public institutions and tech corporations. Moreover, we discovered that every ethical perspective contributes to the identification of different values in unique ways: Utilitarianism inspires instrumental values with a special focus on economic and technical sustainability but also intrinsic values such as "well-being." Virtue ethics complements this set of ideas with a focus on the affected stakeholders' character and good behavior, leading to a set of diverse virtues for each context, which can contribute to a sustainable development of individuals within their social context. Deontology results in the highest proportion of intrinsic values and emphasizes important values and virtues mentioned previously in the analyses, with a focus on intrinsic values and value ideas that relate to social sustainability. These results illustrate that each theory of ethics serves a specific role in the

identification of ethical issues and value potentials of a technology. However, we also find a heavy focus on current mainstream values as well as an overrepresentation of individual values, while social values and environmental issues are neglected. Based on these findings, we conclude that the identification of relevant values should not be open to any theory of one's preference. Rather, the theory guiding an ethically grounded value elicitation process needs to be chosen consciously and carefully. Theories of ethics encourage different perspectives on a specific technology rather than competing with each other, and can thus provide a pluralist ethical grounding for values in technology design.

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Appendix

Table A1. Comparison with value themes and related value codes from Jobin et al. (2019)

Theme	Included value codes (Jobin et al., 2019)	Included codes (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, contentment; 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

Table A2. Frequent values mentioned for each technology and ethical analysis

	Utilitarianism		Virtue ethics		Deontology	
	Value	***N***	***Value***	***N***	***Value***	***N***
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, money	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	Health	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, money	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. *N* shows the percentage of participants that mentioned value (cutoff: 20% of participants); Highlights in gray show overlaps between ethical analyses within each technology.

Figure A1. Share of instrumental/intrinsic values and virtues among the value ideas for each technology

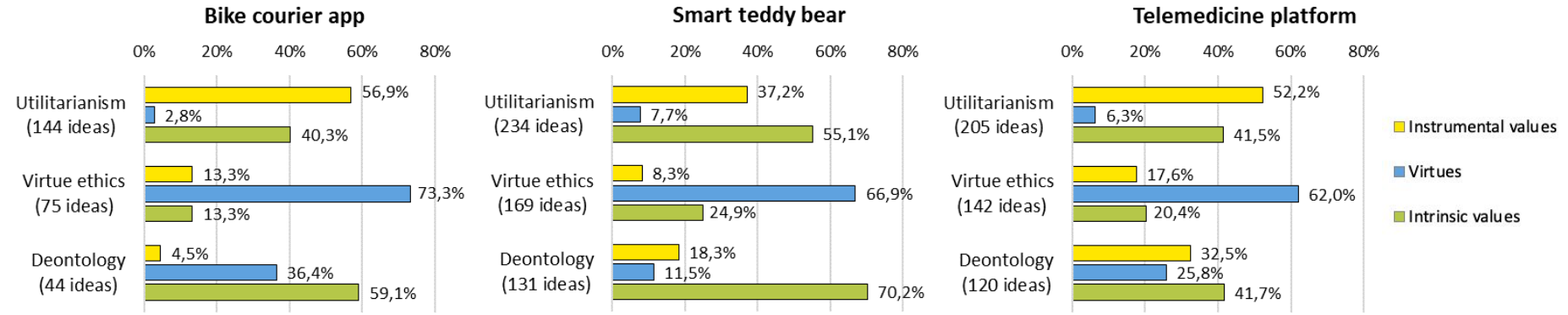
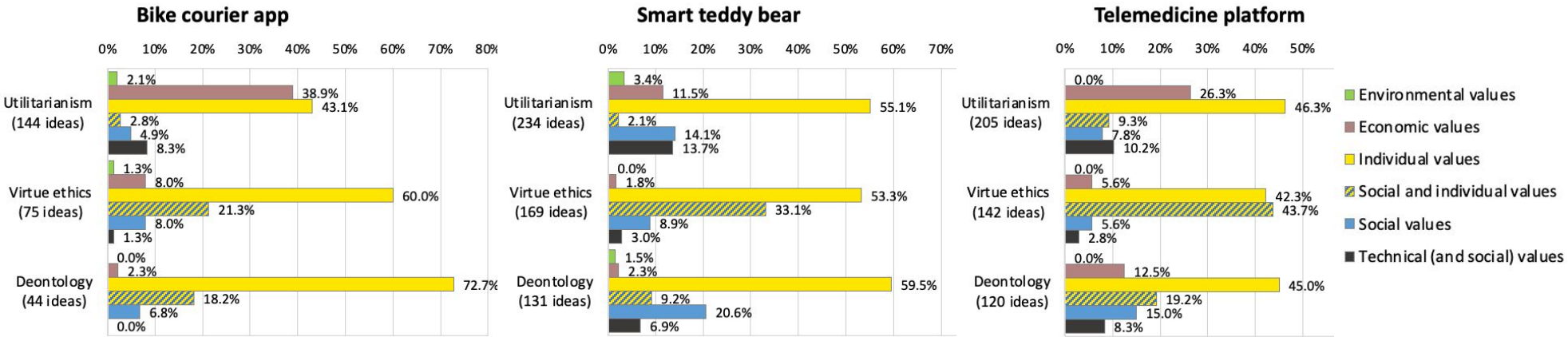


Figure A2. Sustainability dimensions underlying value ideas for each technology



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Anonymized extract from referenced paper

Methodology

In two studies, 71 university students engaged in two innovation management tasks: product roadmapping and value-based product planning. In Study 1, 12 participants worked on a (fictitious) 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. In parallel, 24 participants analysed a (fictitious) smart teddy bear, which targeted two- to nine-year old children. To explore yet another technology, we repeated the procedure one year later. In Study 2, 35 student participants working in teams of two analysed a (real-world) telemedicine system that was presented by the CEO of a start-up company. This telemedicine system operates by connecting patients to a general practitioner who makes an online diagnosis and refers patients to specialized doctors highly recommended by their peers. We only included participants who submitted complete analyses of the respective IT product for both innovation tasks. All three IT products related to existing systems of interest, either in analogue form (smart teddy bear), early version deployment (bike courier app) or as a prototype (telemedicine system).

Value-based Product Planning

In value-based product planning, the perspectives of utilitarianism, virtue ethics and deontology are employed consequently. First, potential benefits and harms that arise for stakeholders (utilitarianism) are noted; then, impacted stakeholder virtues (or vices) are noted; finally, personal maxims that could either be undermined or should be fostered by the innovation (deontology) are identified. This ordering ensures that the three ethical analyses build on each other. The underlying assumption is that different ethical perspectives inspire different ideas and thus complement each other in the ideation phase in product planning. Utilitarianism typically implies the broadest collection of stakeholder effects, both positive and negative; virtue ethics then goes deeper in terms of the concrete effects on stakeholders' long-term character and behaviour; finally, deontology calls for the personal conscientiousness of innovators to identify principles that they would want

to see universally embraced. The innovation task focused on the product characteristics that should evolve from there on.

We have conducted two pilot studies before employing the value-based approach in this way. In the first study, participants employed first the utilitarian, then the deontological, and lastly the virtue ethical perspective. Results showed that 1) the deontological analysis resulted in the least number of ideas and that 2) the resulting ideas from deontology were especially critical. Thus, we decided to employ the deontological analysis as the last ethical analysis. A second study with a between-subject design supported our previous findings, showing that utilitarianism resulted in the highest number of ideas, followed by virtue ethics and deontology.

Sample

On average, participants were 24 (study 1; $M = 23.9$, $SD = 2.6$) and 25 (study 2; $M = 24.6$, $SD = 2.6$) years old and originated from more than ten different nations. In Study 1, 47% of participants were female; in Study 2, 38% of participants were female. All student participants were enrolled in an information systems master programme, which requires 700 full hours (28 ECTS) of computer science training and at least 1,500 hours (60 ECTS) of business management and/or economics training prior to enrolment. Thus, participants had a solid technological and economic background for an IT innovation management task.

Procedure

In order to compare the patterns of results across the two studies and technologies, we kept the study design as similar as possible in a non-laboratory context. In both studies, students first received roughly six hours of introductory lectures on innovation management, including the product roadmapping technique, and were then asked to develop a product roadmap for the respective IT product. They identified product characteristics by reflecting on technological developments and market competition. After completing this first innovation task, the same students received an introduction—once again of six hours' duration—to the three ethical theories of utilitarianism, virtue ethics, and duty-ethics. They learned about the core ethical reasoning of these theories, their most prominent proponents, and how these ethical theories can be used to elicit values and derive product characteristics. Participants labelled all benefits, harms, virtues

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and maxims individually to capture the underlying value. Afterwards, they derived product characteristics that are able to address the respective value in the product design. In the results that we present below, we control for the effects resulting from the order of innovation tasks and applied ethical analyses by excluding repeating ideas for every participant. Note that Study 1 used a word document with tables to collect participants' innovation ideas, while an online interface was set up in Study 2. Also, we required participants to explicitly list potentially affected stakeholders prior to product roadmapping and associate them with product ideas in the value-based approach Study 2. Table 1 in the appendix summarizes the description of ideas we collected from participants and the aggregated factors we derived from this qualitative data for our analysis.

Data Coding and Content Analysis

Innovative thinking is a highly creative exercise (Amabile, 1997). To capture the meaning of the more than 2,000 raw product innovation ideas we collected from participants in the two studies, we applied a mixed-method approach in various data analysis cycles. First, we conducted qualitative content analyses to group the resulting ideas in different categories (see Table 2, Table 3, and Table 4 in the appendix for details). Second, we created variables that showed the frequency of ideas for each participant and category. We used this quantitative output for a statistical comparison of ideas resulting from the product roadmap approach and value-based product planning with regard to the ethical foresight reflected in the ideas and the creative output in terms of different value ideas. In the following, we describe the steps of this mixed-method approach in detail.

In Study 1, we analysed all raw ideas and developed a detailed codebook from the original labelling and idea descriptions of the participants. The codebook represented the original ideas through common labels (=categories) and the direction of effect that could be either positive, negative or neutral. For example, the digital teddy bear sharing data for unwanted reasons would be coded as a "negative" idea relating to "privacy". Two coders applied the codebook independently using the ATLAS.ti software, yielding *good* intercoder agreement for a first sample of ideas ($\kappa = 0.743$ for the smart teddy bear, $\kappa = 0.782$ for the bike courier app; Cohen et al. 1960) and *substantial* agreement for the final coding of the complete dataset of Study 1 ($\kappa = .69$ for the smart teddy bear, $\kappa = .65$ for the bike courier app). After resolving all cases of disagreement, two coders applied the codebook to participants' ideas from Study 2 (the telemedicine system). Again,

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the codebook was iteratively refined and expanded until full intercoder agreement was reached, resulting in 272 final categories, which are described in detail in Table 4 in the appendix.

In a second qualitative analysis, we grouped all idea categories on a higher level of abstraction (Mayring, 2014), allowing us to identify *category groups,* described in Table 2 in the appendix. These category groups comprised ideas that related to *product characteristics* (e.g., "reward system", "health monitoring", or "entertainment programme"), *personal characteristics/abilities* impacted by the innovation (e.g., increased "curiosity", "humour", or "social skills") as well as *emotions*. Among the idea category groups that related to values, we were able to discern two types of values: values that are *instrumental* to other higher values, as well as *intrinsic* values, which are good and valuable in themselves (Hartmann, 1932; Scheler, 1973; Spiekermann, 2016; van de Poel, 2009). Examples of instrumental values typically associated with IT products are "ease of use" and a "nice design", while intrinsic values represent higher goods such as "health", "safety", or "knowledge". We also identified *virtues* such as "truthfulness", "modesty", or "patience" as a third group of value-laden ideas. We consider ideas relating to virtues as "value ideas" as they represent human values inherent in the "disposition, habit, quality, or trait of the person or soul, which an individual either has or seeks to have" (Frankena, 1973, p. 64).

In a third analysis, we qualitatively distinguished between value ideas (i.e., instrumental values, intrinsic values and virtues) that supported different dimensions of sustainability (Penzenstadler & Femmer, 2013), as has been suggested by Winkler and Spiekermann (2019). In a similar process as for the category groups (Mayring, 2014), two coders iteratively assigned every value idea to a value class that supports one of five sustainability dimensions: *technical, individual, social, economic,* and *environmental* sustainability (see Table 3 in the appendix for detailed descriptions), as well as the overlapping area among these dimensions (e.g., techno-social sustainability), until they reached full agreement. Figure 1 presents a schematic overview of the coding process and the developed category system, including the higher-level category groups and value classes. Table 4 in the appendix shows all idea categories and their assigned category groups and value classes.

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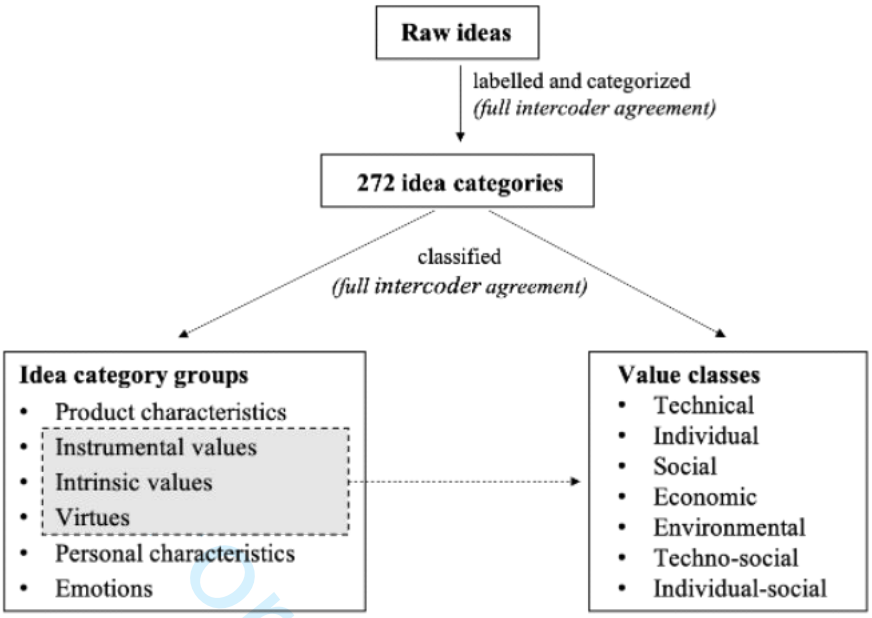

Figure 1. Coding process.

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Appendix

Table 1. Instructions and resulting data structure for the product roadmap and value-based product planning.

Approach	Instructions	Resulting data structure	Deduced factors
Product roadmap			
	▪ Think about the core characteristics that the <product/service> should have. List and prioritize these characteristics over time. Given the <product/service> characteristics, what technical capabilities detail these? Align the technical capabilities needed with the service characteristics you identified. Think about potential competitors of <the product/service>. Does the competitive analysis add any points to your roadmap?	• Analysis of technology trajectory and market competition • Product characteristics • Related technical features • Affected stakeholder(s)	
Value-based product planning			
	a) Utilitarianism: Identify benefits and harms associated with <the product/service> [plus affected direct or indirect stakeholders]. For all benefits and harms reflect on what 'values' they actually relate to. Note down: Which product characteristics could foster/protect these values?	• Potential benefits or harms • Related value(s) • Product characteristics • Affected stakeholder(s)	• Idea labels = categories • Direction of an idea (beneficial or harmful) • Category groups • Value classes • Affected stakeholder(s)
	b) Virtue ethics: Identify good or bad characteristics of behaviour and character (virtues or vices) that could arise in a human being from using <the product/service> in the long run. Note down: Which product characteristics could foster/protect these virtues?	• Potential character benefits or harms • Related virtue(s) • Product characteristics • Affected stakeholder(s)	
	c) Deontology: Identify personal maxims potentially undermined or fostered, which you consider to be of universal relevance and where you believe there is a duty to consider them in the present <product/service> design. Identify the value(s) your maxims are related to. Note down: Which product characteristic could protect your personal maxims and the related values?	• Personal maxims potentially fostered or harmed • Related value(s) • Related product characteristics • Affected stakeholder(s)	

Table 2. Description of category groups.

Category group	Description	Examples
Product characteristics	Product characteristics describe the product/service and its specific (technical) features, capabilities or processes.	Scheduling function, Notifications, Search engine for information
Instrumental values	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 means to 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
Intrinsic values	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
Virtues	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)
Personal characteristics and abilities	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
Emotions	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

Table 3. Description of value classes.

Value class	Description	Examples
Technical values	Technical values describe positive and negative values that are carried by a technology but brings 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

Table 4. Category system showing all 272 categories with descriptions and arranged in category groups (i.e., instrumental values, intrinsic values, virtues, emotions, personal characteristics and abilities, and product characteristics). Value ideas are additionally grouped according to their value class (i.e., economic, individual, social, technical, or environmental). Due to different meanings in the respective IT product's context, „Loyalty" and „Availability" come up twice.

Category group: Instrumental values	
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/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 or 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

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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 stick 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/restaurant (sometimes referred to as "recognition")
Visibility & reputation [harmed]	Product does not promote or 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, e.g., "24/7"
Comfort	The product or system fosters comfort, e.g., when user (e.g., kid or patient) is in distress or afraid
Control	The system grants control to the user, customer, or company, e.g., over the process, over the device, over the application, over the menu etc.
Control [harmed]	The system undermines the control of the user, customer, or company, 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

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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., to achieve a goal, to do sports
Motivation, Encouragement [harmed]	The product/service/system does not motivate the user/customer to do something e.g., to achieve a goal, to 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 rare 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 rare 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 trust in technology for the user, or for society as a whole
Trust in technology [harmed]	The product/service/system harms trust in technology for the user, or for society as a whole
Value class: Social values	
Charity	The product/service/system supports charity, that is, contributing 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 food 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

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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 is highly available, e.g., "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 fosters easy maintenance
Ease of maintenance [harmed]	The physical product or system is designed in a way that makes it difficult to maintain
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) that 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) that ensure that it is 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
Category group: Intrinsic values	
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	

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Autonomy	The product/service/system supports the person's ability to make his/her own decisions or 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 wearing a pink uniform), used merely as means to an end, or rated through numbers
Freedom	The product/service/system fosters freedom, that is, it opens up possibilities 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 tips 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, to not be 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 one'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, to strive for excellence, give your best, and self-improve
Personal growth [harmed]	The product/service/system harms or does not support personal growth, that is, it avoids people from striving for excellence, giving their best and self-improve
Privacy	The product/service/system ensures the privacy/data protection of the user or customer, and/or protects personal data e.g., through anonymity, good privacy policies, asking for consent, and/or protects from surveillance of the user/customer etc.

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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, contentment	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, contentment [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) juridical 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) juridical 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, between 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, between 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; but 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

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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
Category group: Virtues	
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" in case it is stressed that something is done *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 come up 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 care for/taking care of things, e.g., by asking from the couriers to take care of the food they deliver
Caring (about things) [harmed]	The product/service/system does not support people's care 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 support courage in the user but rather makes him/her easily frightened
Diligence	The product/service/system fosters diligence, that is, investing effort and care in doing things well
Diligence [harmed]	The product/service/system undermines diligence, that is, investing effort and care in doing things well
Excellence	The product/service/system fosters excellence, that is, the striving to do something or be something in the best way possible

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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 ability to not waste resources
Frugality [harmed]	The product/service/system harms the ability to not waste resources and be content with less
Gratefulness, gratitude	The product/service/system fosters the gratitude of a person, e.g., customer is thankful to receive the ordered food
Gratefulness, gratitude [harmed]	The product/service/system harms the gratitude of a person
Greed [neg.]	The product/service/system fosters greed, that is, excessive fear of losing something or want for more
Integrity	The product/service/system fosters a person's integrity, e.g., because of fair management decisions
Integrity -	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 or 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 might lose their ability to be patient or be/act impatient/ly
Perseverance	The product/service/system fosters perseverance or persistence, that is, to not stop in spite of difficulties
Perseverance [harmed]	The product/service/system harms or decreases perseverance or persistence, that is, to not stop in spite of difficulties

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Prudence [harmed]	The product/service/system undermines prudence, e.g., by discouraging people to do 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, feel responsible for his/her actions, duties and tasks
Reverence [harmed]	The product/service/system harms reverence, e.g., due to lack of affection and decreased human contact
Self-awareness	The product/service/system fosters self-awareness, e.g., by supporting an 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 means
Selflessness [harmed]	The product/service/system reduces selflessness, that is, valuing others higher than oneself and acting to 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 nerves 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 care for other people
Caring (about people) [harmed]	The product/service/system does not foster people's care or concern for other people or decreases/harms it
Commitment	The product/service/system fosters people's commitment or dedication, that is, binding oneself 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., manager could be generous towards employees

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Generosity [harmed]	The product/service/system harms generosity, e.g., customers are not generous towards 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 makes people be/act friendly with/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 to the company
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, having the right attitude in a situation and acting accordingly
Tactfulness [harmed]	The product/service/system harms tactfulness, that is, having the right attitude in a 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 the attitude of being honest, sincere, truthful, or keeping one's promises
Truthfulness, honesty [harmed]	The product/service/system harms or decreases the attitude of being honest, sincere, truthful, or breaking one's promises
Category group: Emotions	
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) to share 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 share 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

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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 is stressed 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 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 affection, that is, receiving affection from other people or feeling affection towards other people
Affection [harmed]	The product/service/system harms or decreases affection, that is, receiving affection from other people or feeling affection towards other people
Category group: Personal characteristics or abilities	
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 in/does not foster the ability to make good and realistic judgments, e.g., about one's state of health
Good judgment [harmed]	The product/service/system does not support users in/does not foster the ability to make good and realistic judgments, e.g., about dangers, or differentiating between humans, objects, and animals

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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., acting in accordance to rules and orders, to do "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, to initiate 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 coming 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 coming up with confident explanations
Spontaneity	The product/service/system fosters spontaneity, that is, the desire and ability to do something without planning 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 support or fosters social skills, which includes knowledge on 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 or harms social skills or leads to anti-social behaviour
Tech-savviness	The product/service/system fosters abilities and competencies to interact with technologies
Category group: Product characteristics	
"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) is itself able to 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) recognizes its surrounding, objects (feels touch), voices, emotions, speech as input for 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/user), 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")

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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 comes with the 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 to watch out for / take actions against "bad customers" or employees
Emergency handling	The product/system has inbuilt functions (e.g., alarm button) for cases of emergency when the user is in danger, e.g., in case of an accident
Enables 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/fast 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 information, also on the state of a process (e.g., food order, but also about e.g., weather, earnings), to the user or customer
Maintenance: cleaning and charging	The physical product or system's maintenance in terms of cleaning, washing, charging, etc., are described, e.g., "wireless charging", "washable", or "machine-washable"
Monitors external environment	The product/system measures different parameters such as room temperature and humidity in its environment by the use of 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, 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 a message or reminders 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 allows for the evaluation, displays evaluations of or feedback for a service or (human) performance, and/or gives recommendations (based on this)
Remembers and recalls	The product/system remembers users (and their preferences), e.g., learns the child's name

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Remote service	The product/service/system allows 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
Responds 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 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 referred to, e.g., its “weight” on the phone
Subscription plans	Specifics of how users are reached 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 for 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

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