



D7.5 GUIDELINE FOR VALUE-SENSITIVE DESIGN FOR SMART FARMING

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PROJECT SUMMARY

The internet of things (IoT) has a revolutionary potential. A smart web of sensors, actuators, cameras, robots, drones and other connected devices allows for an unprecedented level of control and automated decision-making. The project Internet of Food & Farm 2020 (IoF2020) explores the potential of IoT-technologies for the European food and farming industry.

The goal is ambitious: to make precision farming a reality and to take a vital step towards a more sustainable food value chain. With the help of IoT technologies higher yields and better-quality produce are within reach. Pesticide and fertilizer use will drop and overall efficiency is optimized. IoT technologies also enable better traceability of food, leading to increased food safety.

Nineteen use-cases organised around five trials (arable, dairy, fruits, meat and vegetables) develop, test and demonstrate IoT technologies in an operational farm environment all over Europe, with the first results expected in the first quarter of 2018.

IoF2020 uses a lean multi-actor approach focusing on user acceptability, stakeholder engagement and the development of sustainable business models. IoF2020 aims to increase the economic viability and market share of developed technologies, while bringing end-users' and farmers' adoption of these technological solutions to the next stage. The aim of IoF2020 is to build a lasting innovation ecosystem that fosters the uptake of IoT technologies. Therefore, key stakeholders along the food value chain are involved in IoF2020, together with technology service providers, software companies and academic research institutions.

Led by the Wageningen University and Research (WUR), the 70+ members consortium includes partners from agriculture and ICT sectors, and uses open source technology provided by other initiatives (e.g. FIWARE). IoF2020 is part of Horizon2020 Industrial Leadership and is supported by the European Commission with a budget of €30 million.

EXECUTIVE SUMMARY

Ethics is important for businesses developing technology for the agrifood sector. These technologies raise various value-questions, which may focus on the advantages and risks of data sharing, the fair distribution of benefits between stakeholders or the effects that the use of technology can have on the distribution of power among actors in the value-chain. If these questions remain unanswered, this may have detrimental effects on the uptake, as end-users might not trust the eventual digital product and end up not buying it or using it. Ethical questions therefore need to be taken into account.

To help explore values and ethical values relevant for smart farming technology, we developed this guideline. This guideline is intended for small and medium sized agri-tech startups in Europe who are designing and developing innovative digital technology applications for the agri-food domain. It is these tech businesses that we want to help to explore the values relevant to their technology and to reflect about ethical issues raised during the design process. This can be done with the so-called Value Sensitive Design method. Value Sensitive Design (VSD) is a theoretically grounded approach to technology design that takes into account human values throughout the whole innovation process.

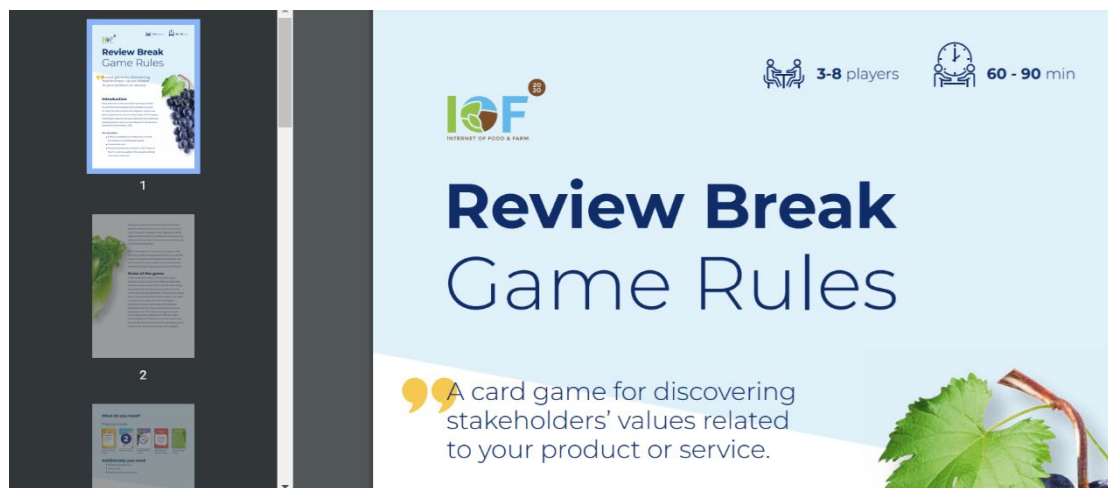
The guideline for value-sensitive-design offers information and step-by-step support to future developers of digital farming technologies interested to take values into account in the development of their technology. The guideline for value-sensitive design has been based on (a) a study of literature on value-sensitive design, (b) the literature study in D7.1 that provides overview over ethical questions about smart farming discussed in the literature (c) the exploration of the ethical questions in the IOF2020 use cases by means of workshops noted in D7.2, as well as (d) our knowledge and experience collected during the supportive work we did for use cases in IOF2020, helping them to deal with the ethical questions that they encountered.



The text of the guideline for value sensitive design is included in this report, but the text of this report is also developed and submitted as a website. This website will remain available after the project IOF2020 ends, and will be available to help developers of smart farming technologies to map the stakeholders, explore their values and reflect on the ways in which these values can best be taken into account. The guideline offers practical information, pictures and examples and various playful methods to reflect on values with your colleagues. The weblink for the value-sensitive design guideline is: https://iof2020.h5mag.com/value_sensitive_design/cover

The guideline offers practical information, pictures and examples. It also includes playful methods in every step of the guideline, which allows to explore who the stakeholders are, what values that these stakeholders find important, and it offers support for dealing with situations in which values conflict.

For these activities the guideline includes a downloadable card game 'Review Break' which is meant to help reflect on a technology under development from the perspective of various stakeholders and explore their values, together with colleagues. Furthermore, it includes also a method for moral deliberation, which can be used when values conflict.



Weblink to cardgame: https://iof2020.h5mag.com/iof2020/edit-value_sensitive_design/step_3/133004/cardgame.pdf

Weblink to the play rules of the card game: https://iof2020.h5mag.com/iof2020/value_sensitive_design/step_3/118206/Game_Rules.pdf
https://iof2020.h5mag.com/iof2020/value_sensitive_design/step_3/118206/Game_Rules.pdf

The movie with an explanation of the card game rules: <https://f.io/0R2vQHHy>

Weblink to the moral deliberation guideline: https://iof2020.h5mag.com/iof2020/edit-value_sensitive_design/step_5/132291/Guideline_ethical_deliberation_v3.pdf



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Guideline Value-Sensitive Design for Digital Farming

This guideline is intended for small and medium sized agri-tech startups in Europe who are designing and developing innovative digital technology applications for the agri-food domain. Initially this guideline has been developed to provide support to the use cases in the Horizon2020 project “Internet of Food & Farm 2020” (see <https://www.iof2020.eu>). The use cases encountered ethical challenges when developing innovative digital products and services for different agricultural sectors.

1. Introduction

Ethics is becoming more and more relevant in businesses developing technology for the agrifood sector. *Why?* These technologies raise various value-questions. These questions may focus on the advantages and risks of data sharing, the fair distribution of benefits between stakeholders or the effects that the use of technology can have on the distribution of power among actors in the value-chain. If these questions remain unanswered, this may have detrimental effects on the uptake, as end-users might not trust the eventual digital product and end up not buying it or using it. Ethical questions therefore need to be taken into account.

We want to help you to include ethics by guiding you to take into account all stakeholders’ values in your technology design and development process. This can be done with the so-called Value Sensitive Design method.

Why this method? Value Sensitive Design (VSD) is a theoretically grounded approach to technology design that takes into account human values throughout the whole innovation process. (see for more information about the phases of VSD box 1):

How are values relevant for design? Technology is not only successful when it functions reliably. It should also be valued by its users. It is for this reason that values should be taken into account during design. For example, it was important to take into account the values of users when designing a mobility application which support blind and deafblind people in using public transport. In the VSD process it appeared that the current technology for blind and deafblind people did not support the values that were most important to them: independence, trust, safety and security, and also affordability and comfort. To better support these identified values, technology developers designed a new system called MoBraille (“mobile braille”), that allows blind and deafblind people to access information via Braille on a small, regular smartphone. Additionally, based on iterative feedback from deafblind people, the tech developers designed a different interface for deafblind people than for blind people (see box 2 for a more elaborate explanation of this example).

BOX 1. THE THREE PHASES OF VALUE SENSITIVE DESIGN

Value Sensitive Design (VSD) consists of the following three phases, therefore it is also called the tripartite methodology (Friedman & Hendry, 2019):

- A conceptual research which includes philosophically based analysis of the central constructs and issues to be investigated. What values do we consider important? How should we make a trade-off between competing values such as access versus privacy, or security versus trust?
- An empirical study which focuses on the human response to the technical artifact and the social context in which the technology resides.

- A technical investigation focused on the design and performance of the technology itself, which concerns both existing technologies and the design of new technical systems.

VSD does not replace but is complementary to the existing user design process of a technology. Like Umbrello and De Bellis (2018: 14) stated: "Value sensitive design can and should be integrated and take into account existent design approaches employed by engineers and designers of intelligent agents."

The application of VSD has resulted in actual changes in or adjustments to the technology design (Winkler and Spiekermann, 2018). There are many examples of technology development projects that used the full tripartite method. Few projects also iterated between the three types of research. By examining the way these projects have applied the VSD method, technology developers can learn how to apply the VSD method for their own technology designs.

BOX 2. EXAMPLE OF AN ITERATIVE VALUE SENSITIVE DESIGN PROCESS - MAKING A MOBILITY APP FOR BLIND PEOPLE

Conceptual research

In the conceptual research the researchers identified the key stakeholders – both direct and indirect stakeholders - related to applications that support blind and deafblind people in using public transport. Then researchers made a first identification of values at stake in the domain. For this, the researchers used the UN Convention on the Rights of People with Disabilities. They also found other values that play a role such as security, trust and privacy. Safety turned out to be very important for the potential users.

Empirical study (1): identifying values

In this phase the researchers conducted 30- to 45-minutes semi-structured interviews with 6 blind adults (2 men and 4 women). The 6 participants gave the highest priority to the values 'independence' and 'trust'. They expressed great concern about 'safety'. The participants often asked other people for information about their environment, but people who give reliable information are not always present. They preferred to access information on their iPhone or GPS system (in accordance with the importance of independence). But getting the information by speech can be distracting and unsafe or difficult to hear when they are in the bus or train. The present professional specialized supporting technology was expensive and inconvenient to carry.

The researchers also conducted 30-minute semi-structured interviews with 7 deafblind adults (4 men, 3 women) and an instructor who provides orientation and mobility training to deafblind people. As with the blind participants, the values of independence, trust and security were prioritized/highlighted in the interviews. All deafblind participants and the instructor associated access to information with the values security and trust. This information is about a person's physical environment (e.g. trees in the middle of sidewalks), bus arrival times, upcoming bus stops and communication with the driver.

The researchers also included bus drivers in the conceptual study because they are the main indirect stakeholders for the technology application. The bus drivers who accidentally transport the blind and deafblind are responsible for the safe arrival at their destination. The researchers sent a survey on drivers' opinions and values to 500 bus drivers. The surveys were completed anonymously. The response was 47%. The survey mainly focused on real-time switching information tools. Part of the survey included questions about passengers who are blind or deafblind. The researchers coded the answers by grouping them into positive, neutral and negative feelings about the carriage of blind or deaf-blind passengers. With few exceptions, responses were very positive.

Technical investigation

Assess current technology

Already in the former empirical research phase, the researchers described current technology, including GPS systems, Braille annotation devices and wearable communication devices especially for deafblind people. These technologies give access to information that provides a certain degree of independence for blind and deafblind people. Other values that were important to the participants were not yet supported by current technology, such as affordability and comfort. Blind participants said that information in Braille had several advantages over information in speech. But deafblind participants have no speech and therefore need Braille devices.

The MoBraille Framework

To better support the identified values, the researchers designed a system that allows blind and deafblind people to access information via Braille on a small, regular smartphone. The system was called MoBraille ("mobile braille").

GoBraille for the blind in public transport

The researchers also developed a MoBraille application (called GoBraille) for the blind that enabled them to get information about (1) the nearest intersection and address, (2) real-time bus arrival for nearby stops and (3) non-visual landmarks and specific location information about nearby stops. In addition, the researchers have also developed a version of GoBraille for deafblind people that gives them real-time information about the bus arrival at his or her current stop. Based on iterative feedback from a deafblind participant, the researchers simplified the interface for deafblind people.

Empirical study (2): evaluating the designed technology applications

Evaluation of GoBraille for the blind

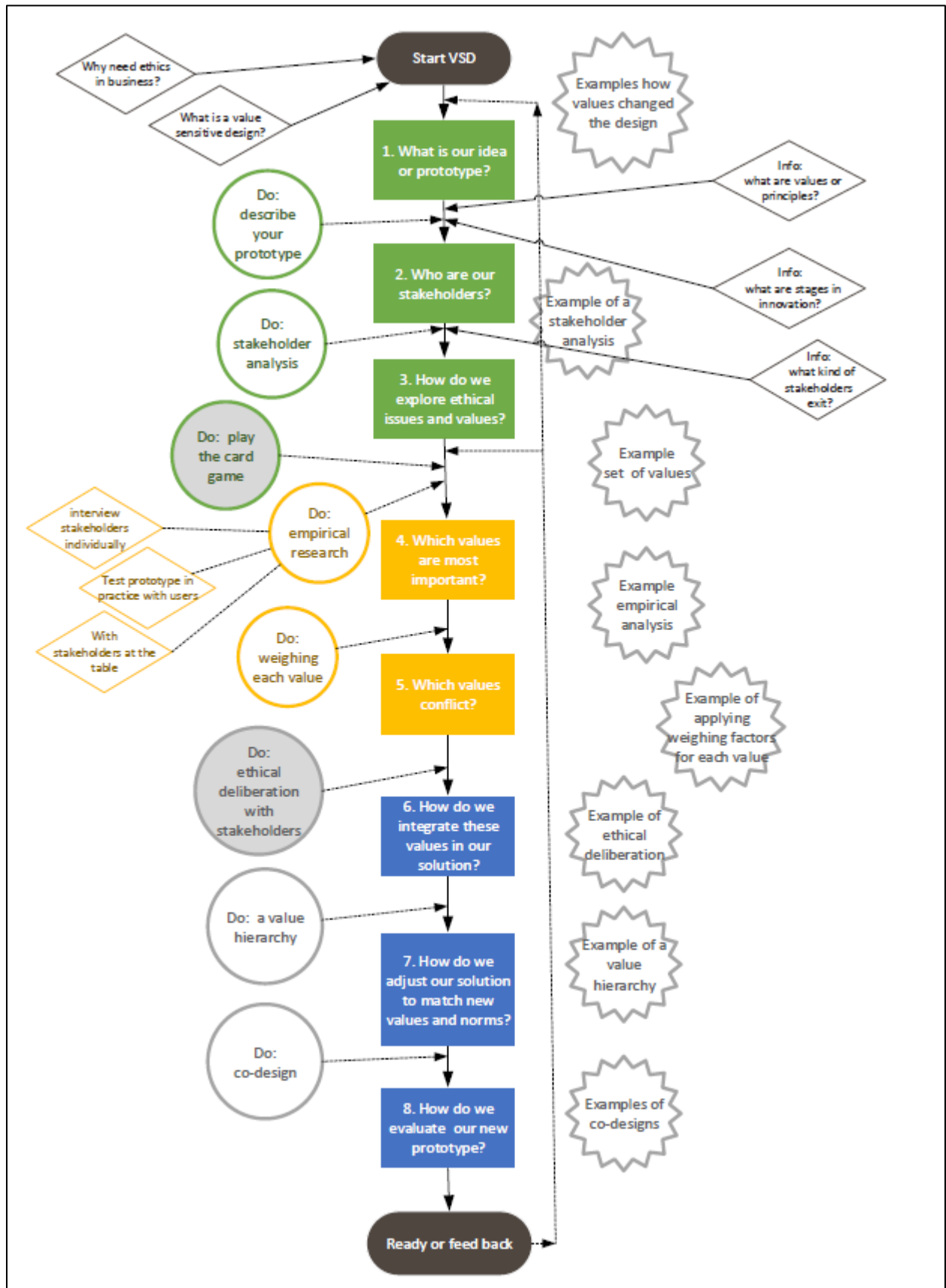
The researchers had GoBraille assessed by 10 blind adults who regularly rode the public transport bus. The evaluation focused on the new aspects of the GoBraille. The evaluation was conducted on a sidewalk of a busy street and near several bus stops. After the researchers explained how the GoBraille application worked, the 10 blind participants were given several tasks to perform using the application. When the tasks were completed the researchers conducted a 20-minute semi-structured interview with the 10 participants. The aim of the interview was to determine how the access to GoBraille's various information sources would affect a participant's sense of independence and security when using public transportation. The researchers wanted to know how the input and output in Braille interacted with the system. It turned out that the participants were very satisfied with the system.

Co-design with a blind-deaf person

The researchers developed a version of GoBraille for deafblind people by working with a deafblind person who used the bus regularly. This happened in 3 sessions of 1.5 hours each. In each design session several problems emerged. The lessons the researchers learned from this co-design process have been translated into three general guidelines that can be used for designing such applications.

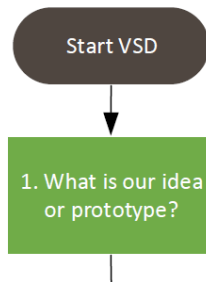
Source: Azenkot, S., S. Prasian, A. Borning, E. Fortuna, R.E. Ladner, J.O. Wobbrock, 2011. Enhancing Independence and Safety for Blind and Deaf-Blind Public Transit Riders. CHI 2011. Vancouver, BC, Canada.

On the next page you find this VSD guideline, explained in 8 steps.



Guideline

Step 1: Describe your conceptual design.



In this step you describe the design or prototype of the technology. The focus of the description should be on the technology and its intended function. We assume that the innovation is still in the research or development phase. In terms of innovation stages, this corresponds to technology readiness levels (TRLs) 1 till 4. TRL 4 means that the technology is validated in the lab and ready to be tested in its relevant environment (for an explanation about the TRLs: https://en.wikipedia.org/wiki/Technology_readiness_level)

Step 2: Do a stakeholder analysis.



What is the result? The result of this step will be an overview over the direct and indirect stakeholders related to the technology design, whose life and/or work will be impacted by the technology.

Why? Because VSD aims to attune the technology to the values of these stakeholders in order to make it valuable to them and increase uptake. To do this you need to know who the stakeholders are.

A stakeholder in the innovation process is either a group or an individual who is potentially affected by the innovation and/or has a (vested) interest.

A distinction can be made between direct and indirect stakeholders. Direct stakeholders directly interact with the technology. Indirect stakeholders do not or rarely interact with the technology itself, but they are nevertheless affected by it. Often, indirect stakeholders are ignored in the design process, but it is better to include them. For example, many computerized medical records have been designed with direct stakeholders in mind, such as insurance companies, hospitals, doctors, and nurses. But values of important indirect stakeholders have been largely ignored: the patients. Taking into account the values and interests of patients would have contributed to making a more acceptable product.

How? There are several methods to identify stakeholders such as, brainstorming, reviewing the literature or conducting interviews. These stakeholders can be noted in a map. (See below, Figure 1). The company that designs and develops the technology is at the center of the map. Direct stakeholders are in the vertical axes, while the indirect ones are in the corners. Box 1 presents an

example of a stakeholders inventory of a fruit case of the Horizon 2020 project Internet of Food & Farm (IOF2020).

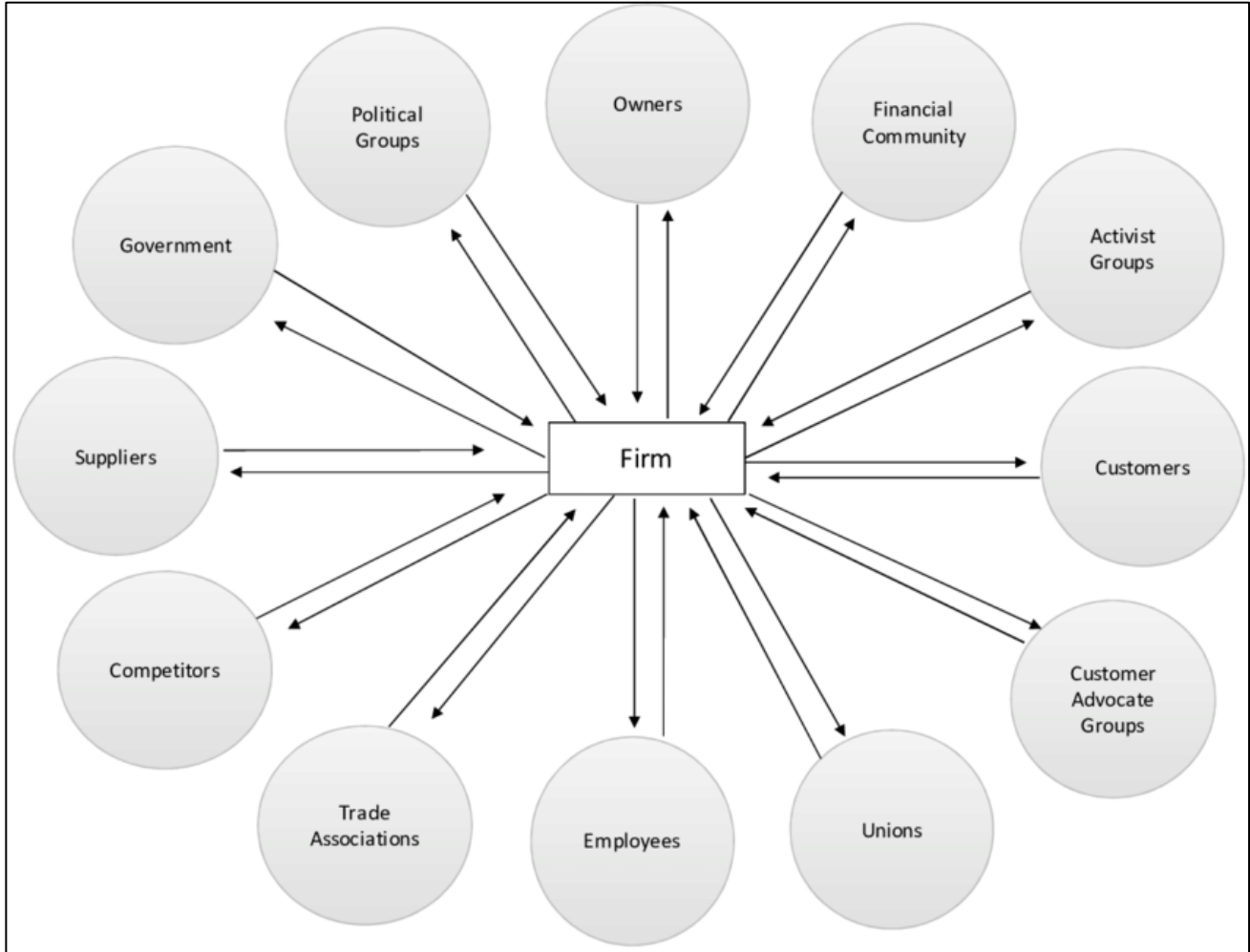


Figure 1. Stakeholder map of a large organization (Freeman, R.E., 2010, *Strategic Management. A Stakeholder Approach*. Cambridge University Press).

BOX 1. EXAMPLE OF A STAKEHOLDERS IDENTIFICATION

In one of the fruit cases of the EU funded Horizon2020 project ‘Internet of Food & Farm 2020’, a technological tool was developed aiming at improving the quality of wine during transport. The tool combines GPS location data and temperature sensor data for temperature monitoring during transportation. The tech provider developing this tool identified the following direct stakeholders: the winemaker/seller and the transport company using the tool. He identified as indirect stakeholders: the wine trader, the insurance company, consumers, and the retailer. Also, a hacker was included as indirect stakeholder to include in the reflection possible harms that hackers could inflict to other stakeholders.

Step 3: Explore ethical issues and stakeholders' values.

3. How do we explore ethical issues and values?

What is the result of this step? This step results in a list of harms and benefits that the technology is expected to produce for each (direct and indirect) stakeholder.

Why? Harms and benefits function as important identifiers of the values of these stakeholders. It is these values that need to be taken into account in the value-sensitive design of the technology.

Harms and benefits frequently raise questions about what is the right or good thing to do. They raise questions about values. In daily life we will usually try to avoid harms and realize benefits. So far, there's no problem. But in some situations, realizing benefits for one person means that one will ignore the benefits for someone else, or even harm that person. In these situations when values conflict, people may doubt what is the best thing to do. When this happens, ethical questions arise. Ethical questions are related to *what a person or group of people consider important in life*.

Usually values underlie benefits and harms. Many lists of values circulate, because contexts differ in which they are discussed. In the agricultural digital innovation project Internet of Food & Farm 2020 a specific list of values has been developed (see box 3). Some values form the core of any value-list about digital technology; such as, privacy, autonomy or well-being/ doing no harm (see box 2: Friedman and Kahn's list of 12 values). Other values are perhaps more specific to digital farming applications, such as environmental sustainability or ownership.

How? There are two ways to explore values of stakeholders. One is low-key and demands colleagues who are developing a technology to **play a card game**. This is the conceptual approach that belongs to this step 3. The other demands to conduct more encompassing empirical research by means of **interviews or a round table conversation** with stakeholders, which is explained in the next step, step 4.

BOX 2. FRIEDMAN AND KAHN'S LIST OF 12 VALUES

In 2003, Batya Friedman and Peter Kahn Jr of the University of Washington – who jointly developed the value-sensitive design approach – compiled a list of twelve values. Friedman and Kahn suggested to include these twelve values (see below with their definition) in VSD. The list is not intended to be complete (Friedman et al, 2013). In a later stage, the value of 'courtesy' was added, meaning that people are treated with courtesy and consideration.

Value	Definition
Human welfare	refers to people's physical, material, and psychological well-being
Ownership and property	refers to a right to possess an object (or information), use it, manage it, derive income from it, and bequeath it.
Privacy	refers to a claim, an entitlement, or a right of an individual to determine what information about himself or herself can be communicated to others
Freedom from bias	refers to systematic unfairness perpetrated on individuals or groups, including pre-existing social bias, technical bias, and emergent social bias

Universal usability	refers to making all people successful users of information technology.
Trust	refers to expectations that exist between people who can experience good will, extend good will toward others, feel vulnerable, and experience betrayal.
Autonomy	refers to people's ability to decide, plan, and act in ways that they believe will help them to achieve their goals.
Informed consent	refers to garnering people's agreement, encompassing criteria of disclosure and comprehension (for "informed") and voluntariness, competence, and agreement (for "consent").
Accountability	refers to the properties that ensures that the actions of a person, people, or institution may be traced uniquely to the person, people, or institution.
Identity	refers to people's understanding of who they are over time, embracing both continuity and discontinuity over time.
Calmness	refers to a peaceful and composed psychological state.
Environmental Sustainability	refers to sustaining ecosystems such that they meet the needs of the present without compromising future generations.

BOX 3. LIST OF VALUES RELATED TO AGRICULTURAL DIGITAL INNOVATIONS

The table below shows examples of values that we came across while discussing innovative digital farming technology in the Internet of Food & Farm 2020 project, as well as in the academic literature like Wright (2011) or Brey (2012). Which values matter is context specific, so it will depend on the specific technology, product or service being discussed.

The table clusters the values in four groups. Three groups refer to values that some authors would call 'principles': to do well/ avoid to do harm, to act fair/just and respect autonomy/ rights of users. The fourth group refers to values that are more specific to digitalisation; such as, data ownership/ privacy.

The table is not an exhaustive list and could be adapted for a specific case or context.

<ul style="list-style-type: none"> • Wellbeing/avoiding harm <ul style="list-style-type: none"> ○ Safety (for man and animal) ○ Health ○ Business revenue, farm income ○ Care for the commons: sustainability, protection of the environment, food security, food safety, knowledge/innovation 	<ul style="list-style-type: none"> • Fairness/Justice <ul style="list-style-type: none"> ○ Fairness/Justice ○ Inclusiveness ○ Empowerment ○ Responsibility/ Accountability ○ Accessibility of data and technology
<ul style="list-style-type: none"> • Autonomy/rights <ul style="list-style-type: none"> ○ Respect for autonomy ○ Transparency ○ Privacy ○ Ownership 	<ul style="list-style-type: none"> • Data ownership (sovereignty) and privacy <ul style="list-style-type: none"> ○ Data ownership /sovereignty ○ Data protection/ data security <ul style="list-style-type: none"> ○ private data ○ competitive data ○ cyber security ○ Informed consent

Do: play the values card game

One way to explore and map the values of direct and indirect stakeholders related to the technology design, is by playing the card game “Review Break”. This game can be played with colleague-developers within the company and without involving stakeholders (see box 4).

Weblink to card game: https://iof2020.h5mag.com/iof2020/edit-value_sensitive_design/step_3/133004/cardgame.pdf

Weblink to the play rules of the card game:

https://iof2020.h5mag.com/iof2020/value_sensitive_design/step_3/118206/Game_Rules.pdfhttps://iof2020.h5mag.com/iof2020/value_sensitive_design/step_3/118206/Game_Rules.pdf

What is the result? The card game invites participants to imagine what values are important for different stakeholders. The result is in a set of reviews of the design or prototype from the perspectives of these stakeholders. (see box 5).

BOX 4. SHORT VERSION OF THE GAME

- 1) Choose the technology design or prototype and describe the technology, its purpose and how it is intended to function in practice.
- 2) Identify the relevant stakeholders, based on the cards provided.
- 3) Each player of the card game draws a hand which determines which stakeholder they imagine to be during the game, the evaluative nature of his review (negative or positive), and the ethical concern or societal impact involved.
- 4) Each player then writes his review.
- 5) All the reviews are collected and read out loud one by one.
- 6) Each review is discussed with all the players.

BOX 5. EXAMPLE OF A REVIEW OF USING GPS AND TEMPERATURE SENSOR TRACKING DURING WINE TRANSPORT

One player has to play the role of the wine trader and has to consider the value of ‘inclusiveness’. The following review about temperature sensor tracking during wine transport can result:
“The general idea behind the system is ok, because wine conditions are more secured during transport. But the additional costs for me are too large to join the system. Also, now that there is more transparency, there are more issues to solve during transport to maintain the quality of the wine. It is not yet clear who will handle these issues.”

Two other ways to explore and examine the values of the direct and indirect stakeholders is by doing interviews, or by inviting them for a round table discussion.

1. Interview stakeholders individually

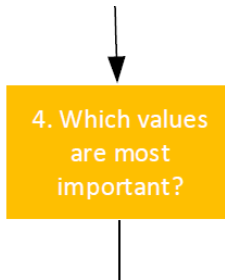
The agri-tech company will interview the stakeholders (or commission others to interview stakeholders, e.g. researchers) to find out what values they consider most important. During these interviews, it is important to (a) present the idea for the technology, (b) ask what this stakeholder thinks the possible harms and benefits are and (c) explore the values that are important for the various stakeholders. For step c it can be helpful to use the lists of values (Box 2 and 3)

2. Round table discussion with stakeholders

The company sits down with stakeholders and discusses which values play a role in technology design. In a round table discussion there is more space for reflexive exchange between the participants, which can help to identify and map possible conflicting values. During the workshop it is

important to (a) present the idea for the technology, (b) ask participants to note the anticipated pros and cons of this technology for them and explain them and discuss them with the group, and (c) explore the values by allowing participants to choose their top 3 values related to the technology and discuss that in the group again.

Step 4: Determine relative importance of the values.



What is the result of this step? This step will provide an overview over the values that deserve to be prioritized in the design of the technology.

Why? It is important to find out which values are most important and deserve to be taken into account in the design of the technology.

How? Here you should use the output of step 3 which will be a list of values. In this step the tech developers themselves determine which values are most important. They can do this by ascribing a weight factor to each value: in the form of a number. This indicates the relative importance of each value or -in other words- their relative ranking for different stakeholders, such as noted in the following table (see for a more elaborate description box 6).

	Tech developers	Farmers	Policy makers
Ownership	10	10	1
Fairness	3	10	3
Care for the commons	1	5	10
Transparency	10	3	10

In some situations, however, values will conflict, or stakeholders prioritize different values. These situations may raise ethical questions. Whenever such questions come forward, it may be important to move to step 5, which asks to deliberate about the right answer to these questions and come to a conclusion. If values do not conflict, step 5 can be skipped.

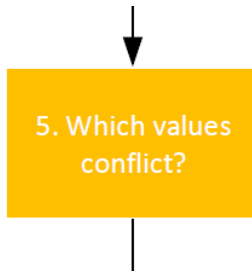
Box 6. EXAMPLE OF APPLYING WEIGHT FACTORS TO EACH VALUE

For the roll out of smart meters for energy use in the Netherlands the relative ranking of values of stakeholders was examined by Van de Kaa et al. (2019). Their focus was lying on the acceptance of smart meters. First, they reviewed the literature on technology acceptance for smart metering, in order to explore relevant values. This list of values was screened by interviewing a panel of experts with extensive knowledge on dimensions of acceptance. This resulted in a set of values for each of the groups of stakeholders: privacy, environmental sustainability, compatibility, cost-effectiveness, trust, reliability, autonomy, justice. The next step was that experts were asked to evaluate the importance of the values for the acceptance of smart metering, and they were asked to empathize with the general public in order to answer what society would think about certain matters. The experts were asked to determine the most

important value (which is called the *best*) and the least important value (which is called the *worst*) of each set of values. They determined the weight of values with regard to each other, in order to identify those that are most important for the acceptance of new technology.

Source: Kaa, van de G., J. Rezaei, B. Taebi, I. van de Poel, A. Kizhakenath (2019). How to weigh values in value sensitive design: a best worst method approach for the case of smart metering.

Step 5: Examine value conflicts.



What is the result of this step? The previous step may have pointed out that some values conflict, which can give rise to ethical questions. This step will provide a method to work towards an answer to those questions, which will attend to the values of all stakeholders and which will help technology developers to progress on their technology.

Why? Value conflicts may hinder further development of the technology. They can be considered as constraints on the design space. Examples are; the support for the value 'food safety' may jeopardize the realization of 'privacy', as food safety may demand to trace unsafe foods back to the origin of the contamination and this may reveal the identity of the source. Other typical value conflicts may include environmental sustainability versus economic competitiveness, transparency versus security or knowledge sharing versus remaining competitive (see box 7 for more examples relevant for the agri-food domain).

The purpose of ethical deliberation is trying to come to an agreement about the best way to solve the conflicts between values. The final goal is making better products and services and improve their acceptability among users.

How? Basically, ethical deliberation is a structured discussion. Preferably, representatives of relevant stakeholder groups are included in the discussion. For practical reasons, you can also do the deliberation with a mixed group from the project development team (e.g. from finance, legal, sales, production section etc.), who are engaged to play the role of stakeholders. In this case you should identify the external stakeholders' interest and concerns based on the earlier steps 3, and 4. Find detailed instructions on how to do the deliberation in the guideline for ethical deliberation (Weblink to the moral deliberation guideline: <https://iof2020.h5mag.com/iof2020/edit-value-sensitive-design/step-5/132291/Guideline-ethical-deliberation-v3.pdf>)

Box 7. EXAMPLE OF CONFLICTING VALUES

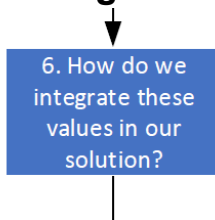
A slaughterhouse decided to organize an ethical deliberation with all stakeholders, because their ideas about a data platform received mixed reactions. In their view this platform had to integrate slaughterhouse data with farm data to improve pig feeding, providing an algorithm which prescribes what feed pigs should get, as in a feeding machine.

Pig producer organization 1 welcomed the feeding algorithm as it is supposed to give advice on feed and treatment. The organization underlined, however, that the system should leave room to

the farmers' own decision making. Farmers in this organization wonder who will have access to all the farm data and fear that this data platform will finally lead to a situation in which the slaughterhouse could control them and then will prescribe what kind of feed should be used and how to take care of the pigs. Also, part of the farmers in this organisation are reluctant to do investments in this technology, because they decided they will stop farming within five years.

Pig producer organization 2 that produces organic pigs, does not like the idea of introducing an automated feeding machine at all, as it could interfere with the natural feeding behaviour of pigs. It shares the worries of pig producer organization 1 on the access to the data and also fear that the system might develop over time into an instrument to control them.

Step 6. Integrate values in your design.



What is the result of this step? This step will result in a list of value-based requirements for the design of the technology. It is the first step of the technical investigation phase of Value Sensitive Design.

Why? It needs to be investigated whether and to what extent the values identified and prioritized in the previous steps can become part of the design of the technology. To do this you will analyze the specific characteristics of the technology and use the values to specify the requirements for the design.

How do you do this? By making a value hierarchy (see box 8 for an example). A value hierarchy helps to make the translation from values into concrete design requirements. The figure below illustrates this. The top layer of this figure shows the **values** that you identified, such as for example 'respect for autonomy' which demands to foster someone's capacity to make choices freely, based on relevant information. The middle layer translates this value into **norms**. These norms could be prescriptions (commands) to do actions but also restrictions (prohibitions), such as: 'choose the option that supports/enhances the autonomy of users' or 'refrain from manipulating/steering the decisions of users in a direction'. Based on these norms, you can formulate **design requirements** by further specifying what compliance with the norms would mean for the design of the technology. For a technological system that aims to foster autonomy, you could identify design requirements such as: (a) always reveal the different options for action available, (b) provide information about the rivaling options for action, (c) foster decision making by showing the pros and cons of different options. The relationship between the three layers is not deductive, but it involves translating one layer into the next.

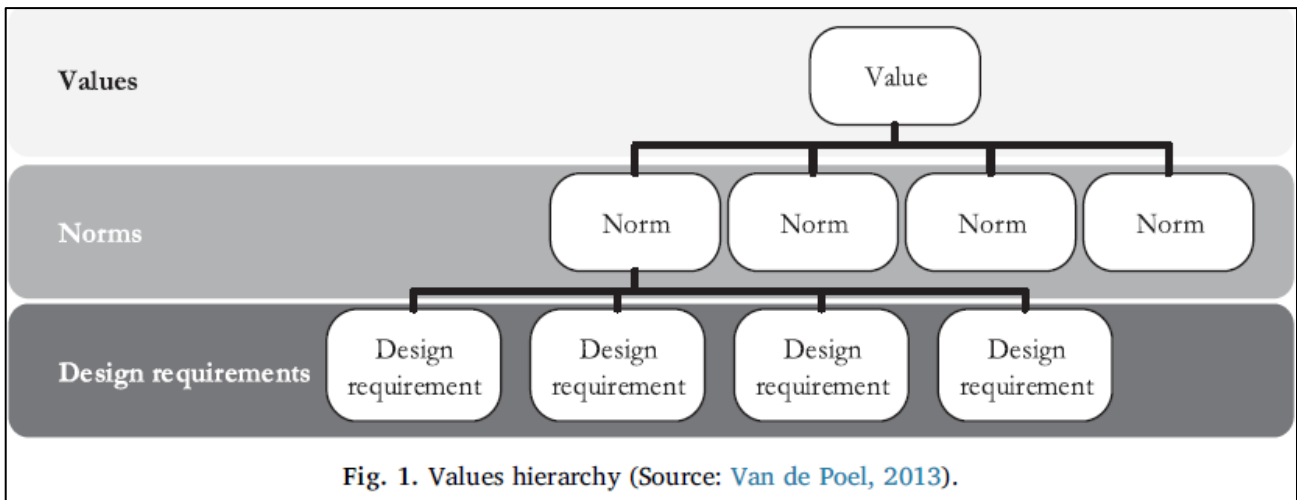
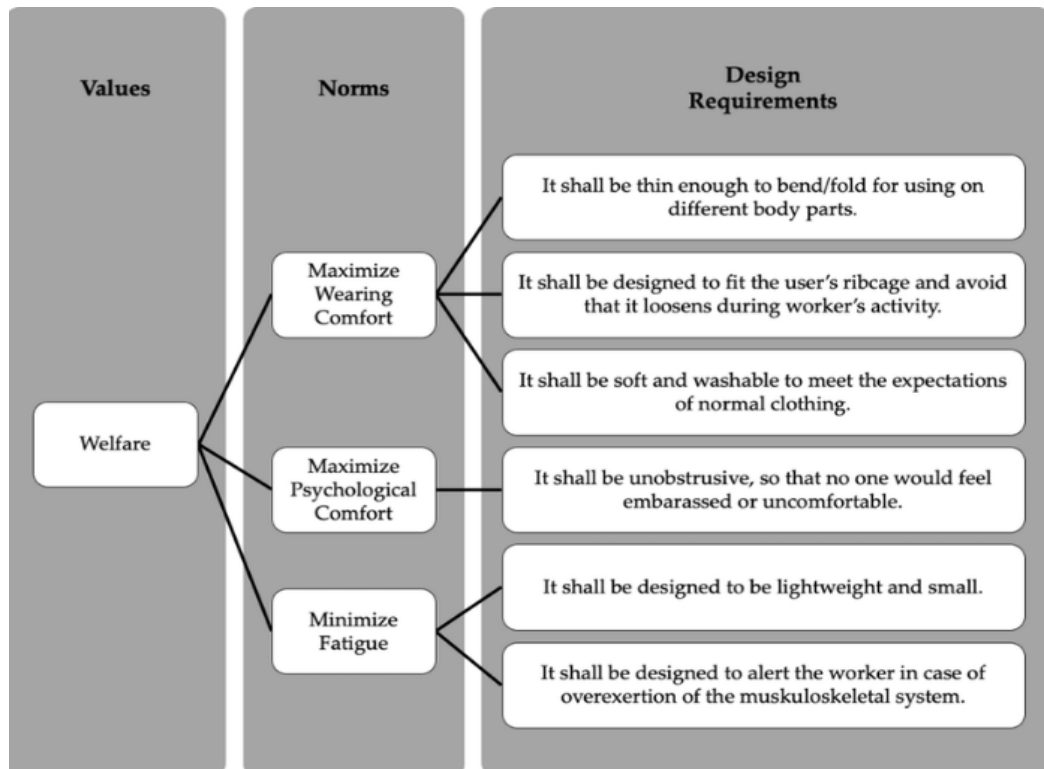


Fig. 1. Values hierarchy (Source: Van de Poel, 2013).

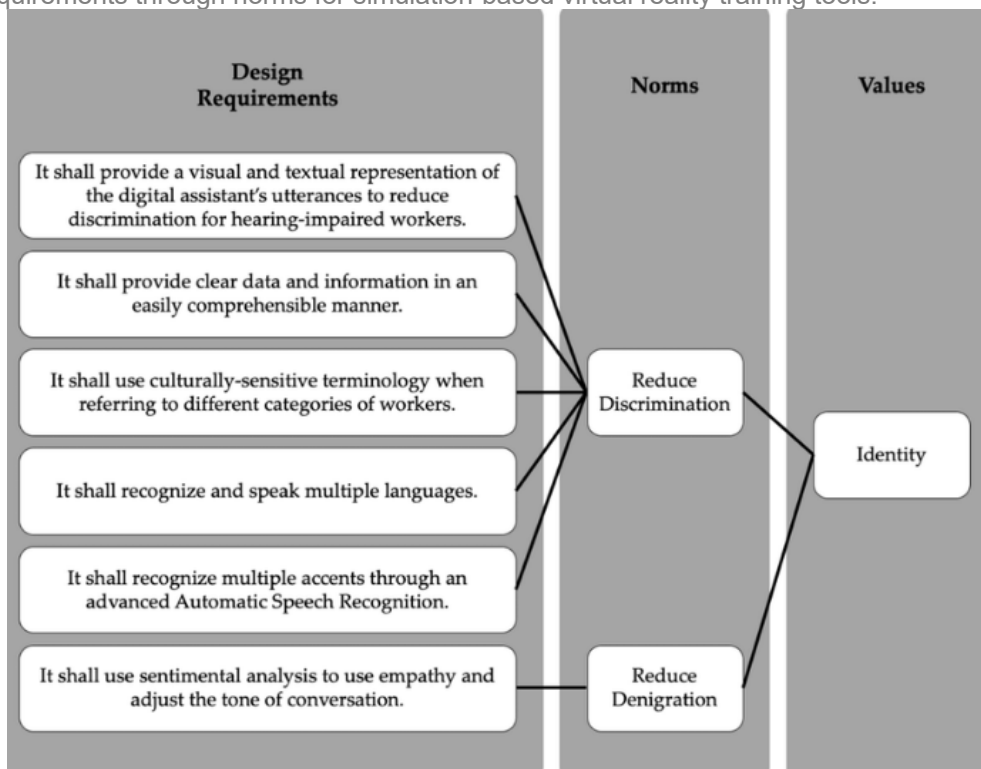
BOX 8. HOW TO MAKE A VALUE HIERARCHY

Value Sensitive Design was originally developed as an ex ante method for designing technical objects to ensure that design requirements properly reflect the underlying values. However, if you are dealing with an already existing technical system rather than making a completely new design, the VSD is more about adaptation or revision. In that case the acceptance of the technical system can be improved by redesigning the technology application. For that you can construct the value hierarchy by both a top-down and a bottom-up approach. In a bottom-up approach you have to look for the motivation and justification of the design requirements at the bottom level. You can also start by identifying norms (which can be found in debates, newspapers, etc.) and then determine which values are related to those norms.

- Top down approach: how the value of welfare is translated through norms and into technical design requirements for wearable technology.

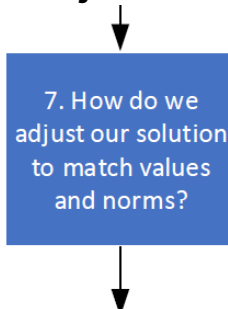


- Bottom up approach: how the value of conformity is extrapolated from technical design requirements through norms for simulation-based virtual reality training tools.



Source: Longo, F., A. Padovano, S. Umbrello (2020). Value-Oriented and Ethical Technology Engineering in Industry 5.0: A Human-Centric Perspective for the Design of the Factory of the Future.

Step 7. Adjust design to values and norms.



What is the result of this step? In this step human values are incorporated into the design process. It can lead to a different design of the technology or prototype.

Why? It is the purpose of Value Sensitive Design to integrate values in design, in order to help make the product more acceptable to end-users.

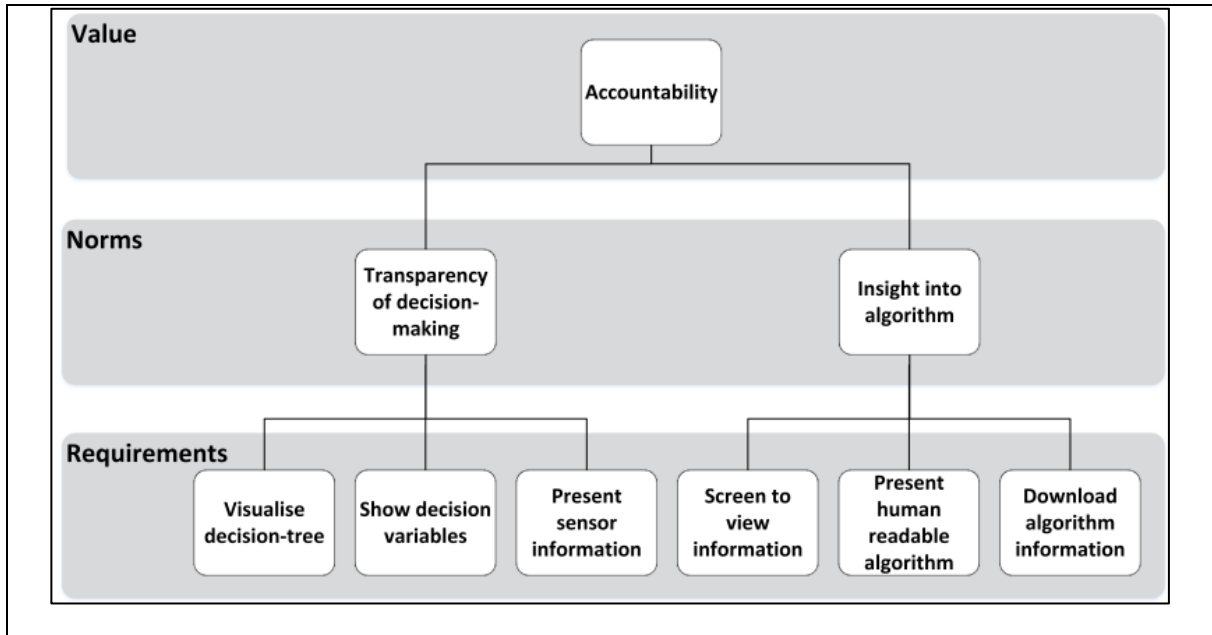
How? By adjusting your design or prototype to the values in the iterative stages of design. Based on the requirements identified in the previous step, you look for the technical possibilities to realize the values and you adapt the design of the technology. Thus in this step you adjust the technology design or prototype to match the values and norms identified in all previous steps (see box 9 for an example). If not all values can be realised in the design of the technology, you can also focus on changing the environment or social context in which the technology will be used instead of adapting the design or technology.

BOX 9. EXAMPLE HOW CERTAIN VALUES CHANGED THE DESIGN – A DRONE FOR MILITARY USE

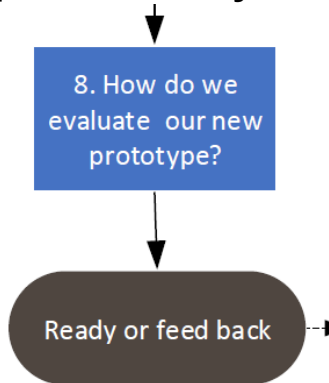
The **value** 'accountability' was considered very important for the design of a drone for military use. This value is translated into the **norms** '*always make sure that decision-making is transparent*' and '*provide insight into the algorithm*', which allow users to understand the choices made by the autonomous weapon. In this way, the actions can be traced and justified (see figure below).

The norm '*transparency of the decision making*' has led to the following additions to the design requirements: i) offer transparent insight into the decision tree, ii) present the decision variables of the autonomous weapons used (for example trade-offs in collateral damage percentages of different attack scenarios) to provide insight into the proportionality of an attack; iii) make sure that the autonomous weapon presents the sensor information - for example imagery of the site - to show that it makes a correct distinction between military personnel and civilians.

In order to meet the norm 'provide insight into the algorithm', an autonomous weapon must be designed with three features that were not included before: 1) a screen as user interface showing the algorithm in 2) a humanly readable form and 3) the functionality to download the changes made by the algorithm as part of its machine learning skills that can be investigated by an independent party e.g. a United Nations war tribunal (Verdiesen, 2017).



Step 8. Evaluate your new design.



What is the result of this step? This last step will lead to an evaluation of your value sensitive design or prototype.

Why? It is important to check whether all values that were identified in previous steps have been sufficiently taken into account in the design and/or whether this had led to a design that is acceptable and appreciated by end-users.

How? There are different ways to do this. First, you can look back to the values identified in step 3 and 4, the value conflicts and the solutions you developed for the conflicts in step 5, as well as the design requirements developed in step 6. Based on all these previous steps you can assess whether the eventually resulting design or prototype is acceptable.

But you can also do the evaluation with stakeholders. If the previous steps 3, 4 and 5 have been carried out without the participation of stakeholders, it is recommended to involve them in step 8. This is the best way to 'check' whether the values that you think are important for the stakeholders, conform to the values that these stakeholders consider important.

Note that Value Sensitive Design always includes an empirical phase. Therefore, it is important to include stakeholders and ask for their opinion at some point in the process. Below you will find an example of an interview protocol to evaluate the design of the product/service with users (see box 10).

Box 10. EXAMPLE OF AN INTERVIEW PROTOCOL FOR USERS

After presenting the concept for your product or service, you could ask the envisioned users to use the application. You could evaluate through the following questions:

At first glance: would you be interested in buying this kind of product or service?

- If yes: why do you appreciate the product? What particular aspect you like most? Why?
- If no: why would you not be interested? Is there any particular reason why?
- Show a list of values that were identified before as important for the design (or use the list in the glossary):
 - Which three values do you consider most important in relation to this application? Why do you think they are important?
 - Which three values are clearly addressed by this product or service? In what way?
 - Which three values are at risk when this product is introduced and used? In what way? How big are these risks according to you? Are there any ways to mitigate these risks, what are these ways? What needs to be done? By whom? Please explain.
- If preconditions to realize those values are accomplished and risks are mitigated: would this change your interest in the product or service?
- Given these considerations, what would your opinion be about this technology application? What are its merits/flaws?

Appendix – A Glossary of values and related questions

The values, definitions and questions in this glossary are aimed at the design of smart farming products and services. Colors refer to the blocks in Box 4.)

- Wellbeing / avoiding harm (green)
- Fairness / Justice (orange)
- Data ownership and security (grey)
- Autonomy / rights (blue)

Value	Definition and remarks	Questions for products and services
Accessibility	The product or service is easy to obtain or use.	<p>-Is the technology/system accessible to all potential users that might benefit from it? If not, who has access to the technology and who does not have access?</p> <p>-What education/training is required prior to using the technology? Does the new technology or service or application expect a certain level of knowledge of computers or require facilities (e.g. broadband internet) that that some people may not have?</p> <p><i>-Should digital tools be accessible to every farmer? (digital divide)</i></p> <p><i>-What is the best way to deal with power imbalances in society between those who possess digital knowledge and expertise and those who don't?</i></p> <p>-Are some services being transferred to the Internet only, so that a service is effectively no longer available to people who do not (know how to) use computers or the Internet? What alternatives exist for such people?</p> <p>-If there are means of resisting the provision of farm data, are these means equally available or are they restricted?</p>
Accountability/ responsibility	<p>Impacts by a product or service can be traced back to someone who therefore can be held responsible for them.</p> <p>Remark: Accountability is a legal term. If accountability is unclear (where, when who is</p>	<p><i>-E.g. in the case the situation is produced by more than one actor or by a combination of technology and an actor: who should be accountable for these effects? Should accountability be distributed over various actors?</i></p> <p><i>-Who is responsible/liable for damage that occurs after a farmer acted on the (wrong) advice of a tool? Or when the tool missed information? Who should compensate for damage/harms?</i></p>

	responsible?) then we have an ethical issue.	<p><i>-If farmers choose to ignore the advice of digital tools, are they to blame for results?</i></p> <p><i>- Is it fair to make someone responsible for the effects of bad luck?</i></p> <p><i>-Does it make sense to speak about shared responsibility of stakeholders on a digital farm? And what does this mean in case of an accident or system failure?</i></p>
(Respect for) Autonomy	The product or service respects self-determination of the user.	<p><i>-Does the potential user have a meaningful choice regarding not to use the solution? Are there (realistic) alternatives available? If not, what could be done to provide real choice?</i></p> <p><i>-Are farmers who use digital (advisory) technologies still the primary responsible decision makers on their farm?</i></p> <p><i>- (When) is it acceptable for smart farming technology to steer the actions of others (like farmers)? Is steering always paternalistic? Or is it like nudging? And what does this entail for the responsibilities of farmers at their farm?</i></p>
Data ownership/ Data sovereignty	<p>Having the right to access, use and control a set of data.</p> <p>Remark: Sometimes the term 'data sovereignty' is used to refer to farmers right to reclaim data and use them to inform themselves about their own farm.</p>	<p><i>-What data are we talking about: raw data or processed/interpreted data?</i></p> <p><i>-Who has the right to access these (raw/processed) data? Are there disagreements about who does and who does not have that right? For what period can data be kept, re-analyzed and re-used?</i></p> <p><i>-Who is the 'owner' of (raw or interpreted) farm data and is entitled to benefit from them?</i></p> <p><i>-Who is the owner of the data about the farm machinery?</i></p> <p><i>-Who is entitled to decide about who has a right to data, for what purposes and under what conditions?</i></p> <p><i>-Is there an obligation to data philanthropy?</i></p>
Care for commons	Public goals such as protection of the environment, food safety or food security, research or policy making.	<p><i>-What rights do partners in the data sharing network have with respect to access and use of data for 'the commons'?</i></p> <p><i>-What public goals are or should be served with the product or service? Or with data that</i></p>

		is shared? Or with the technology? Are there other purposes for which data/information should be shared?
Data protection/ data security	Protect data from misuse and unauthorized or unintended access (such as hacking or cyberattack).	<ul style="list-style-type: none"> - Has the project taken measures to ensure protection of (sensitive) data? If so, what are they? -<i>What data/information are considered 'risky' to share and in whose hands do they become 'risky'?</i> -<i>What protective measures can be taken to diminish risks?</i>
Empowerment	The product or service enables people to defend their own interests in negotiation with others.	<ul style="list-style-type: none"> -Does the project or technology or service make users stronger by educating them or offering them knowledge? - Does it enable users to defend their own interests in negotiation with other (more powerful) parties?
Fairness/ Justice	<p>-Fair or just distribution of benefits harvested from this product or service by the stakeholders, such as data, information/ knowledge, profits, power.</p> <p>Remark 1: Fairness and justice are often used interchangeably. Justice is sometimes understood to refer to the legal system. In ethical debates the legal system itself needs also ethical argumentation, in order to determine whether it is just.</p> <p>Remark 2: Distributive justice refers broadly to the distribution of all rights and responsibilities in society, including, for example, civil and political rights (W)</p>	<ul style="list-style-type: none"> -<i>What are the conditions that a just/fair distribution of benefits of digital farming should satisfy?</i> -<i>What are the benefits of smart farming that should be distributed fairly?</i> -<i>What human rights play a role in smart farming and how are they effected? Are the rights of some people served better than of others?</i> -<i>Are benefits and harms that the solution produces well balanced? Who will benefit and who may be harmed? Is this justified?</i> -<i>Are there stakeholders who can be harmed by this smart farming solution? In what ways can stakeholders be harmed? Is this a justifiable harm?</i> -<i>Should everyone be empowered to benefit equally from data? (big data divide)</i> -<i>What counts as misuse of power by digital experts? Who risks to be harmed by that misuse? And how should this misuse be prevented?</i>
Inclusiveness	The technology used in the product or service should not exclude particular (groups of)	-Does the product or service have any effects on the inclusion or exclusion of particular (groups of) people?

	<p>people, depending on gender, age, social status, disability etc.</p> <p>Remark: in the design process of a product inclusiveness also refers to the inclusion of the views of all stakeholders whose lives are impacted by the technology</p>	<p>-Who's se lives are impacts by the technology? Have representatives of these groups been involved in an evaluation of the desirability/acceptability of these impacts?</p>
Informed consent	<p>Permission granted in full knowledge of the possible consequences.</p> <p>Remark: Informed consent is not a value, but a way to respect the autonomy of the user.</p>	<p>-Is the user person capable, legally competent and are the purpose and risks of the product or service known?</p> <p>-What information do farmers need to make an informed choice?</p> <p>-What information can data collectors/users such as ICT companies or researchers be requested to provide? Are there limitations to the volume or depth of information that they can be expected to provide? See also transparency.</p>
Ownership	<p>The right of possessing something. Ownership is the state in which someone has exclusive rights and control over property.</p>	<p>For questions relating smart farming: see data ownership/ data sovereignty</p>
Privacy	<p>The product or service protects (personal) data from misuse and does not reveal information on what stakeholders consider their private life or business secrets.</p> <p>Remark: This definition refers to informational aspects of privacy.</p>	<p><i>-What does respect for privacy require in digital farming?</i></p> <p><i>-Does a farmer's business or trade secret belong in the private sphere that deserves protection?</i></p> <p><i>-What information about (activities on) his farm is a farmer allowed to keep for him/herself?</i></p> <p><i>-What information workers on farms allowed to keep for themselves?</i></p>
		-
Responsibility/ Accountability	<p>See Accountability</p>	
Sustainability	<p>The service supports food production in which people, planet and profit are in balance, not to exhaust resources for next generations.</p>	<p>See questions care for commons.</p>
Transparency	<p>Stakeholder's right to know about how people behave, businesses</p>	<p><i>-Does the farmer have a right to know what an agribusiness does with his raw/processed data?</i></p>

	<p>operate and digital services work.</p>	<p><i>Are there limits to the level of transparency that can be provided about what happens with data?</i></p> <p><i>-Does the government have a right to know certain information about farms? Are public, purposes for which data/information should be shared? And what does 'public' mean?</i></p> <p><i>-Do other stakeholders have a right to know such as retailers, consumers, citizens? For purposes for which data/information should be shared?</i></p> <p><i>-Who is allowed to decide about this level of transparency? (Who is, for example, entitled to decide what information about food production is shared with consumers?)</i></p> <p><i>-Incidental or secondary findings are findings you are not looking for, but which you find 'by accident' in the course of looking for something else. What incidental or secondary findings can be expected? What is an appropriate way to respond to these different incidental or secondary findings?</i></p>
<p>Wellbeing/ avoiding harm</p>	<p>The product or service supports being comfortable, healthy, or happy (of human beings and animals).</p>	<p><i>-Who benefits from the product or service and in what way? (How) does the solution foster the wellbeing of human beings and/or animals?</i></p> <p><i>-How is wellbeing (of human beings/animals) understood? Are there alternative ways to understand it?</i></p> <p><i>-Is there any risk that the technology or project may cause any physical or psychological harm to users? If so, what measures can be adopted to avoid or mitigate the risk?</i></p> <p><i>-Is there any risk that the technology or project may cause any economic harm to non-users? If so, what measures can be adopted to avoid or mitigate the risk?</i></p>

Source: Questions in italics are based on IOF Deliverable 6.2 Otherwise questions are based on Wright, David. (2011). *A framework for the ethical impact assessment of information technology*. In *Ethics and Information Technology* (2011) 13:199-226.