Data Donation:

Engage Users in Ethical Data-driven Design

Master Thesis 2020
Strategic Product Design
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Master Thesis

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Acknowledgements

Completing this graduation thesis would not be possible without the support of professionals, family, friends and participants.

Thanks to:

Jakcky and Sander , you understood my decision of going back to my country before graduation because of the Covid-19 pandemic. Though it was not an easy job to work completely online, you carefully guided me from the period full of confusions to the end with lots of gains.

My parents, with your support, I could have the chance to study at Netherlands, at TU Delft. I feel so lucky to have your love all along this two-year journey.

Ruiqi, Chenjing, you shared your experience of doing the graduation project with me and encouraged me to overcome so many difficulties.

All participants, you provided valuable information during the interviews and tests, which became an indispensable part of this thesis.

Abstract

Data donation is a potential means of feeding more data into data-driven projects. However, little is known about how it differs from existing data collection methods used by designers and what influences individuals' act of donating data to design projects. By conducting expert interviews with a prototype of the Data Donation System and user tests with an interactive prototype of the Data Donation App, I've proposed a system of donating data to design projects in an ethical manner. The findings mainly contribute to adding new knowledge of applying data donation in domains outside of healthcare research and guiding designers and their team to motivate users to donate their data to design projects .

Contents

1

Introduction

Donation is not a rare act happens in our daily life. We may donate money, services or goods such as clothes, books and food as a gift for charity, humanitarian aid or to benefit a cause (Wikipedia, 2020). To satisfy medical needs, some people are willing to donate their blood or organs for transplant. Apart from the forms of donation mentioned above, it is hard to ignore the exponentially growth of data produced in the digital era we live in. Though data itself doesn't have any meaning, it can be processed into certain forms with meanings that are valuable for people or organizations. Therefore, the topic of 'data donation' is drawing increased attention in public and scientific research.

In fact, there have been many attempts of data donation in healthcare domain. Patient data such as diagnoses, procedures, imaging reports and laboratory tests that are collected in clinical studies as well as health data including daily steps, food intake and heart rate that are tracked by individuals with their mobile phones or wearable devices can be donated for healthcare research through the Apps like VITALx (DATEVA, n.d.) and Data Donation Pass (Schapranow, 2017). These data not only aid doctors with early and better diagnoses but also fuel ground-brake discoveries in medical research.

However, the data we produce are far more than health data and donating data to other fields is less explored. In this thesis, I made a further investigation in terms of how to support data-driven design through data donation. To seize innovation opportunities in the booming data-driven businesses, designers become more and more data-aware. If people could donate their data to designers or their teams, they would have a brand-new access to data and take it as a new material for data-driven design. On the other side, individual users have a chance to use their data on their own initiative in a way of donation rather than just giving consent to companies collecting their data because it is the precondition of using their products or services. Research questions include: What could affect users to make the decision of donating their data to design projects? How does data donation differ from the data collection methods commonly used in design at present? What forms of data do designers want to receive and can users provide?

To explore a more concrete mechanism of donating data for design

projects, I narrowed down the scope of 'data' to smart home data and set the theme of 'design projects' as sustainability-related. Based on that, a trend scanning was made to find opportunities and predict future situations, from which I was inspired to conceptualize a Data Donation System built on the future vision of the Personal Data Bank. I took it as a probe, combined with the Value Sensitive Design methods, to interview experts with experience in data-driven design. Their answers helped me to revise the Data Donation System and conceptualize the Data Donation App that bridges the gap between designers who request for data and users who produce data in a tangible way. Then, I prototyped the key features of engaging people to donate their data in the form of clickable user interfaces, which was also taken as a probe to get smart home users' concerns and motivations about donating their usage data for design projects. After analysis, the Data Donation System was iterated to the third version which integrated data subjects' perspective with data receivers' perspective.

My work contributes to improving the understanding of donating data for design projects:

1. Propose a data donation system that balances the values from users and designers.

2. The findings of users' motivations of donating data can be taken as a reference by designers and their teams to engage user in their design project

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Literature Review

This chapter reviews literature on related theories of data-driven design, the legal feasibility and motivations of data donation, and the ethics of designing a data donation mechanism. It also helps to form a comprehension of the terminologies and general background before interviewing experts in Chapter 5.

2.1 Data-driven Design

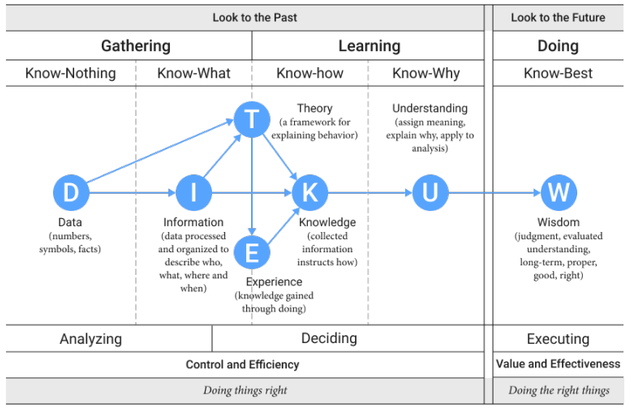
Data-driven design has become a buzzword among designers recently, but 'data driven' has been around for so many years. In the past, designers were expected to create pretty items according to the decisions mainly made by product managers, engineers and analysts. They got insights from dealing with data, and these insights drove projects to move forward.

Now, designers have caught on and are getting more and more involved in these decision-making stages. Their suggestions through design perspective start to influence the project direction and solve more business problems. Their design goals get aligned with overall business goals more often. This is because data has been considered as one kind of indispensable design material, which balances the subjective trait of design by its objectivity. Instead of replacing creativity in design, making an appropriate use of data enables designers to confirm their intuition, verify their assumptions and have a seat at the table.

2.1.1 DIKW Hierarchy

According to Ackoff (1989), cited as the initiator of the Data Information Knowledge and Wisdom Hierarchy (DIKW) in knowledge management domain, data are symbols that represent the properties of objects and events. A further elaboration of his definition could be: Data is raw. It can exist in any form, usable or not. It does not have meaning of itself (Gu & Zhang, 2014). Therefore, the value in data needs a process to dig it out, and the DIKW Hierarchy indicates this process where data are transformed to more understandable forms, or to say forms with meanings.

Figure 1: DIKW Hierarchy based on Ackoff (1989)



Information is contained in de-

scriptions, answers to questions that begin with such words as who, what, when, where, and how many (Ackoff, 1989). In this level, data has been relationally connected and the context around an object is revealed.

Knowledge is conveyed by instructions, answers to how-to questions (Ackoff, 1989). It can be considered as "actionable information" that allows people to make better decisions and to provide an effective input to dialogue and creativity (Jashapara, 2004). Though knowledge has useful meanings for people, it does not provide for integration such as would infer further knowledge of itself (Berlinger et al., 2004).

Understanding is a cognitive and analytical process that follows Knowledge. It is conveyed by explanations, answers to why questions (Ackoff, 1989). In this level, people are able to take knowledge and synthesize new knowledge from the previously held knowledge (Berlinger et al., 2004).

Wisdom deals with values. Unlike data, information and knowledge which enables people to increase efficiency, wisdom is the ability to increase effectiveness. It is efficiency multiplied by value, efficiency for a valued outcome. Therefore, wisdom involves the exercise of judgement (Ackoff, 1989), which relates to an individual's belief system. When reaching this level, people can see beyond the horizon (Awad & Ghaziri, 2004) and act critically or practically in any given situation (Jashapara, 2004).

In Ackoff's view, the first four levels deal with what has been or what is known. Only wisdom level relates to future, as visions are embodied in it. Designing a product or service is not for past but for future use. Only by moving through data, information, knowledge and understanding levels successively can designers achieve wisdom. But it is not easy to convert from one level to the next. As the sequence is a bit less deliberated than described by Ackoff, Bellinger holds the view that understanding supports the transition from each stage to the next. Understanding is not a separate level of its own (Berlinger et al., 2004).

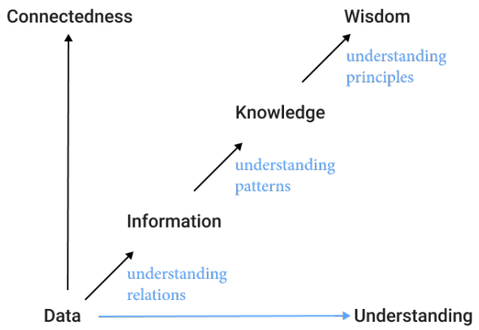


Figure 2: Berlinger's (2004) interpretation of DIKW Hierarchy

2.1.2 Designing with Data

The term 'data' can be divided into two types: quantitative data and qualitative data. Qualitative data are measures of 'types' and may be represented by a name, symbol or a number code (Australian Bureau of Statistics, 2013). They are generated through audio and video recordings, observations and notes, interview transcripts, images and symbols, and so on. Quantitative data are measures of values or counts and are expressed as numbers (Australian Bureau of Statistics, 2013). Analyzing this type of data requires knowledge of mathematical statistics, which is out of some designers' comfort zones.

With the development of digital technology, people's activities in physical world, such as having conversations, listening to music, sharing pictures etc., have all been digitalized. Now, these activities can be logged, tracked and even analyzed with ease, which means we have an easy access to data. This is evident in the case of using smart phones: Screen Time (Apple Inc., 2020) feature of iPhone records how much time users spend on apps, websites, and more. These (quantitative) data are displayed in a well-organized chart which informs users to decide how to use their device next. Not only users are supported in decision making by their behavior data, designers can also incorporate these data into digital product design and make decisions that meet users' needs.

King, Churchill and Tan (2017) introduced three ways to think about how data and design have been positioned in the industry: data driven, data informed, and data aware. Data-driven design implies that the data that is collected determines (in other words, drives) design decisions. When designers have figured out what the problem is, what the goal is, and framed a precise and unambiguous question, they can be data driven. Being data informed allows designers to understand how their data-driven decisions fit into a larger design space of what can be addressed. The result of this type of design may not be a clear choice but a setup for another iteration or investigation. Data-aware design underscores the fact that the design process is a creative one, where design decisions need to be taken back to data collection practice. There are many related questions and also related types of data that designers can draw on to answer a variety of questions.

The authors argued that if designers haven't properly worked through the consideration of being data aware, they can't get to the data-informed stage; without thinking about problem space in a data-informed way at some point, designers can't be data driven (King et al., 2017). It is acknowledged that divergent periods and convergent periods follow each other in a design process. At the very beginning of many projects, there should be a divergent period, in which designers have freedom to do lots of explorative work. Therefore, a data-aware approach in this period can prompt designers to collect various types of data from a wide range of resources and find out many interesting questions. After that, they will have a better understanding of users and context which is the design space of a data-informed approach. By iterating their assumptions for several times, designers get closer to the real problem they should solve and the goal they want to achieve. Such a convergent process leads to the data-driven stage. A data-driven decision is built on designers' effort in data-aware design and data-informed design.

Summary 2.1

The DIKW hierarchy explains the principle of data processing but it is not especially made for design projects. The four levels actually present four forms of processed data. Data-aware, data-informed and data-driven approaches focus on how designers dealing with data in the divergent and convergent design periods, so they are the supplements to the DIKW theory. For this research, it is important to figure out what forms of data designers (or their teams) could receive and wish to receive from data donation in practical work.

2.2 Data Donation

In the digital era, all of us generate massive amounts of personal data as we go about our daily lives. These data are rich resources of understanding people's behaviors and lifestyle choices. Given that many people have already donated precious properties such as their money, blood or even organs for the benefit of others and society, donating personal data in support of good purposes is very likely to be a new norm in the near future. The opportunity for designers here is that people may be willing to donate their data to support innovative design projects.

2.2.1 The General Data Protection Regulation (GDPR): Right to Data Portability

Nowadays, more and more daily activities are performed with digital technology involved. Trials of data individuals leave are harvested and harnessed by industries that produce these digital products or services to optimize their business. For instance, music-listening data in Spotify indicate users' preferences of certain music genres; transport data in Nederlandse Spoorwegen (NS) evidence passengers' daily contexts; residence data in IKEA smart home devices encodes families' lifestyles. While people provide a stream of personal data containing valuable information for companies, they don't have much power to control the use of such data on their own.

In fact, GDPR legitimizes the rights individuals have about personal data collected on them in EU. Within the 'Right to Data Portability', the data subject is able to receive the personal data concerning him or her, which he or she has provided to a controller, in a structured, commonly used and machine-readable format and have the right to transmit those data to another controller without hindrance from the controller to which the personal data have been provided (Art. 20 GDPR – Right to Data Portability, 2016). The law indicates that individuals are free to either store the data for personal use or to transmit it to another data controller (Skatova & Goulding, 2019). If people are willing to share some of their personal data to designers, a great range of untapped pre-existing data resources will be opened up and drive design process from the bottom up.

2.2.2 Motivations of Donating Data

Although it is possible and legal for data subjects to transfer their personal data to other data controllers, the question that what motivates people to engage in such a donation still remains.

Skatova and Goulding (2019) considered personal data donation as a new act of digital economy 'prosocial behavior'. Prosocial behavior is a term that describes social acts carried out to benefit other people or society as a whole (Twenge et al., 2007), including helping, sharing, donating, co-operating, and volunteering (Brief & Motowidlo, 1986). Such behaviors may be altruistically motivated by empathy or by cares about the welfare of others. Egoistical concerns such as one's social status or reputation, hope for direct or indirect reciprocity, or adherence to one's perceived system of fairness (Eisenberg et al., 2007) may also drive people to behave in a prosocial manner.

When it comes to why people would like to donate their data, Skatova and Goulding's (2019) study reveals related motivations. The strongest one is the desire to serve society and give back to community. On the other end of the spectrum, the strongest predictor for the decision of not donating data is the need to gain direct benefits as a result of data donation. The need to know the consequences of donating data is another important factor affecting the decision whether to donate. Unlike being clear about for what purpose the blood will be used in blood donation case, people are uncertain about what information can be derived from the data they donated, as well as feel a bit worried about data misuse. This is because understanding data is a process with several levels. It's hard to clearly explain rationales behind the move from data to information, knowledge and wisdom. The authors extracted three scales –– Social Duty, Self-interest and Purpose from these motivations respectively. Though this study is within the domain of donating data for academic healthcare research, the scales can still be applicable to other data donation fields to some extent.

Apart from motivational factors, the perceived reliability of the data receiver and the type of data being donated also influence people's willingness to donate personal data.

Summary 2.2

The GDPR legitimize the rights individuals have about personal data collected on EU. Users have the right to retrieve their data collected by the companies through the products or services they supply and transmit these data to any people or organization as they want. Though the law proves part of the feasibility of donating data, the motivation behind donation is an indispensable factor of achieving a data donation. The literature in this section introduces three scales including social duty, self-interest and purpose from the different motivations. It lays a theoretical foundation for exploring what motivates users to donate their data for a design project in the later chapters.

2.3 Ethics and Technology Design

2.3.1 The Mediating Role of Technology

When technologies are used, they always help to shape the context in which they fulfill their function (Verbeek, 2008): human perceptions and actions are shaped; new ways of living are created. The term 'technological mediation' was coined to describe this phenomenon, where technologies mediate the experience and practices of their users (Ihde, 1990; Latour, 1992; Verbeek, 2005).

Technology is a moral agent which plays an active role in human's moral action and decision-making. Analyzing the moral agency of technological artifacts has important implications for technology design. The moral aspects regarding to technology development include not only weighing technological risks and preventing disasters, but also taking responsibility for the future mediating roles of the technology in design.

In order to address the moral aspects of technology development adequately, the ethics of technology should expand its approach to include technological mediation and its moral relevance, enabling designers to take responsibility for the quality of the functioning of their design, and for the built-in morality (Verbeek, 2008).

Technological mediations are no intrinsic qualities of technologies, but are brought about in complex interactions between designers, users and the technologies (figure 3, on netx page). Designers play a seminal role in realizing particular forms of mediation. Users with their interpretations and forms of appropriation also have a part to play; and so do technologies, which give rise to unintended and unanticipated forms of mediation (Verbeek, 2008).

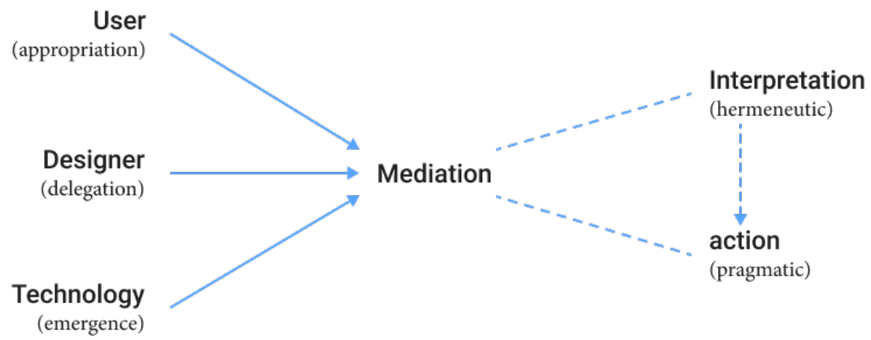


Figure 3: Origins of technological mediation (Verbeek, 2008)

2.3.2 Designers' Responsibility

In order to cope with the unpredictability and complexity of technological mediation, it is important to seek links between the design context and the future use context (Verbeek, 2008). Designers could try to formulate product specifications not only on the basis of the desired functionality of the product but also on the basis of an informed prediction of its future mediating role and a moral assessment of this role (Verbeek, 2006).

During the design process, designers can make such a prediction, which can be regarded as a mediation analysis, by imagining how technology could be used and by shaping users' interpretations and actions from that perspective. Though performing a mediation analysis cannot guarantee that all relevant mediations will be anticipated by designers, it is still what designers can exert their greatest efforts on to take a responsibility for the mediating roles of the products they design.

Summary 2.3

According to the Verbeek's (2008) theory, data donation is a new 'technology' that changes the way users handle their data and the way designers obtain data, so they are both the 'users' of this technology. As I did this research to investigate the data donation mechanism involving both designers and users, I am the 'designer' of data donation 'technology'. I should take the responsibility to consider unexpected use cases of data donation that may hurt 'users' interests or not in line with 'users' values.

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Approach

Based on chapter 2, the main research question can be framed as: ***How to engage users in donating their data to design projects in an ethical way?*** I deconstructed this broad question into 3 sub-questions.

- What could affect users to make the decision of donating their data to design projects?
- How does data donation differ from the data collection methods commonly used in design at present?
- What forms of data do designers want to receive and can users provide?

This chapter narrows down the scope of these questions by limiting the 'data' to smart home data and setting the theme of 'design projects' as sustainability-related. Based on that, the main methods applied to find answers of above questions are introduced.

3.1 Research Scope

As the topic of sustainable development gains wide attention these days, designers also get involved in creating new products and services that are environmentally friendly and energy-saving. Smart home devices or systems record rich usage data in users' daily lives. These data are likely to be donated by users to support sustainable design related projects, which will be beneficial to the living quality of both present age and later ages.

Therefore, I set my research in the scope of donating smart home data to support sustainable product design. The data subjects are people who use devices such as lighting, air conditioners and water heaters with sensors and smart controllers at home. I chose young singles or young couples to form the target data subjects group in the user tests, because they are more sensitive to the changes brought about by emerging technologies than older age groups. Designers who work in agencies or startups with experience in designing with data were targeted as the data receivers.

3.2 Value Sensitive Design Methodology

Value Sensitive Design (VSD) is a theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout design process (B Friedman et al., 2002). In VSD the focus is on incorporating human and moral values into design of (information) technology (van den Hoven et al., 2017). When applying VSD in design practice, there is a tripartite methodology: conceptual, empirical and technical investigations.

3.2.1 Conceptual Investigation Phase

Conceptual investigation aims to define the values that should be focused on during design process. It focus on questions such as what are values? Whose values should be supported or diminished? How are values supported or diminished by particular technological designs? (Friedman et al., 2002) and so on.

Since data donation is not a common practice at present but likely to

be popular in the future, I conducted a trend scanning in Chapter 4 by using the PEST-analysis model. PEST is an acronym for four sources of change: political, economic, social and technological (Sammut-Bonnici & Galea, 2015). The trend scanning in this phase helped me to imagine future scenarios and explore opportunities in the research domain. During the process, I also became more clear about what values should be investigated.

3.2.2 Empirical Investigation Phase

Empirical investigation is carried out to analyze the human context where the technical artifact is situated. Quantitative and qualitative research methods in social science may be useful here to explore how stakeholders apprehend individual values in the interactive context, how they prioritize competing values in design trade-offs, how they prioritize competing individual values and usability considerations and etc. (Friedman et al., 2002).

In this phase, stakeholders' interactions with data donation mechanism were investigated. I applied multiple VSD methods (Friedman et al., 2017) to map out stakeholders and elicit values from their evaluation of the Data Donation System (Chapter 5) and experience of using the Data Donation App (Chapter 6) through expert interviews and user testing.

3.2.3 Technical Investigation Phase

There are two forms of technical investigation. One form focuses on how existing technological properties and underlying mechanisms support or hinder human values, and another form involves the proactive design of systems to support values identified in the conceptual investigation (Friedman et al., 2008). It seems that technical investigation is similar to empirical investigation because they both include technological and empirical activities. But technical investigation focuses on the technology itself, while empirical investigation centers around people who use or affected by the technology.

In this research, I designed the Data Donation System and the Data Donation App (users' end) to investigate an ethical mechanism that could engage users in data-driven design. I focused on users and designers who are affected by the Data Donation System and didn't go further into the technical investigation that would study more technical issues around the Data Donation System.

VSD Methods

Direct and Indirect stakeholder Analysis
"In any stakeholder analysis, a central distinction concerns of stakeholders who directly interact with a system, the direct stakeholders, and those who, although they never or rarely interact with the system as the end-users, are nevertheless affected by the system, indirect stakeholders."

Value Scenario
"Depending on the context of use, a value scenario can act both as a values representation and as a values elicitation method."

Value Tensions
"People's values can align or come into tension at various levels of human experience – within an individual; among individuals; between an individual and a group; among groups, institutions, nations, and societies; and any number of other combinations. Adding yet another layer of complexity, the balance among the values of a person, group, or society may change over time, and value tensions my shift accordingly. While how to achieve balance among competing values is not obvious, value sensitive design frames a design process that engages constructively with the tensions."

Value Sketch
"Sketches, collage, and other visual expressions provide a means to tap into non-verbal understandings."

Value-oriented semi-structured interview
"Semi-structured interviews provide a means to tap into stakeholders' understandings, views and values (Kahn, 1999; Piaget, 1929/1960). Interview questions can be honed to elicit information about values and value tensions in relation to technology… The semi-structured nature of the interview provides an opportunity to pursue topics in depth as well to engage new considerations the stakeholder introduces into the conversation."

Value-oriented Coding Manual
"Coding manuals provide one systematic means for coding and then analyzing qualitative responses to value representation and elicitation methods, such as the value scenario (e.g., narrative), value sketches (e.g., visual), and semi-structured interview (e.g., discourse) methods described above… Each coding category contains a label, definition, and as a rule of thumb up to three sample responses from the data."

cited from Friedman et al. (2017)

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Trend Scanning

Emerging trends that are likely to have an impact on the use of personal data generated in smart homes are discussed in this chapter. I employed a PEST-analysis model to categorize and give an overview of such trends.

4.1 Socio-cultural Trends

Work from Home in the Post-pandemic Era

The COVID-19 crisis seemingly provides a sudden glimpse into a future world, one in which digital has become central to every interaction, forcing both organizations and individuals further up the adoption curve almost overnight (Blackburn et al., 2020). As widespread of lockdowns have been issued in the pandemic, many employees are forced to work from home with the support of lots of digital tools. Apart from adopting working software for remote collaboration, many employees re-setup their homes to create a more comfortable space for living and working, which is also a chance for them to accept a more digitally connected lifestyle. According to a recent survey conducted by S&P Global Market Intelligence, 67% of the enterprises expect their work-from-home policies to remain in place either permanently or for the long-term (COVID-19 Shakes Up the Future of Work, 2020). From employee's side, a survey conducted for LinkedIn by Censuswide shows that 82% of employees want to work from home at least once a week and 57% of them want at least three days a week (Heimann, 2019). Therefore, working from home has great potential to be a new norm in the post-pandemic era. The opportunity for the smart home domain lies in the fact that people will spend more time at home, have more interactions with their smart devices and create abundant data that can be processed to empower innovation.

Young Generations' Tech Anxiety

Young generations are future home residents and potential smart home customers. Thus, their attitudes towards smart home technology and data usage is crucial to the design of data donation mechanism. According to the Accenture report, Putting the human first in the future home (Earley et al., 2019), while millennials are happy to see the benefits brought by smart home technology such as it makes their life easier and more fun, they have some concerns.

The research shows that 43% of the respondents aged 18 to 34 are fearful that smart devices know too much about them and 50% respondents in this age group worry that they are too dependent on technology. This

means young generations are able to reflect on human-technology interaction. Their anxiety about privacy and data security in smart homes will force companies re-examining the ethical issues and uncovering the digital world behind tangible devices to users. On the other hand, the data donation mechanism would relieve such anxiety by engaging them to exert their ownerships on personal data. Instead of fearing for being controlled by someone else, they probably are willing to decide who can make use of their data.

4.2 Economic Trends

Collaborative Data Economy

Organizations are now linking and connecting diverse datasets at an accelerating pace to create value, and this is one of the primary factors shaping today's global economy. From 2017 to 2019, the number of companies forming data-related partnerships rose from 21% to 40%. A growing number of business competitors are also deciding to connect their data – rising from 7% to 17% (Hoffman et al., 2019).

This rising trend of data collaboration is likely to break up data monopolies, where large data firms are capturing all surplus value created by data, amassing unprecedented wealth and exacerbating income and wealth inequality (United Nations, 2019). If data can be transferred among companies, especially large firms open the access to part of their data sets, it will be easier for many small firms to take advantage of these data and stay competitive in the market. Otherwise, dominant firms would expand or just maintain their market shares without necessarily being more innovative.

4.3 Political Trends

Explicit Ethical Frameworks

More and more jurisdictions are adapting data protection and privacy rules by way of legislation. Such rules are designed to offer a level of control to individuals in respect of the collection and processing of data about them by digital service, governments, or even peers, depending on the jurisdiction the law (Flanagan et al., 2020).

However, regulation is often one step behind technology. While human-computer interactions go beyond the screen, such as smart home devices ambiently collecting personal data via sensors, the current requirements of Notice & Consent for personal data collection and processing usually need the display of a privacy policy notice on the screen. Therefore, it is not practical for people to give consent in many no-screen situations. Besides, the emerging IoT devices deepen the interconnection of different elements in society, where the data-sharing relationships get more complicated and absolute autonomy of personal data at an individual level is impossible. Because the Fair Information Practices Principles (FIPPs), a set of principles in response to the growing of the digitalization, primarily value individual control and personal autonomy as the goal of data protection (Flanagan et al., 2020), the impacts that individual data sharing decisions have on the society are overlooked.

The challenge in front of policymakers is how to appropriately regulate these data privacy issues caused by rapid technological changes of the Fourth Industrial Revolution. Comparing with fixing surface-level flaws, policymakers should establish explicit ethical frameworks that will guide regulation and focus more on understanding human needs in the future context.

Data Trust Legal Structure

The tension between exploiting personal data to empower innovation (for the common good) and protecting users' right to privacy and right to know (may prevent data from transit) starts to grow. How to balance these competing needs becomes an unprecedented challenge for the policymakers. Strengthening trust among individuals, companies and governments that are involved in data-sharing chains is the core of solutions.

Legally, a trust is a structure that enables one party, the trustor, to give another party, the trustee, the right to hold an asset for the benefit of a third party. The beneficiary and trusts have historically been used to hold assets such as property or investments (Flanagan et al., 2020). It has been suggested that data trusts can be used to form a governance in which data is freely given and data collectors and processors own duties of care and trust to data subjects (Edwards, 2004). To interpret this structure within the smart home data usage domain, the trustor could be a household who generates data through daily use of smart home devices; the trustee could be an oversight authority who holds private smart home data in a secure manner and advocate for the personal data rights of the household; the beneficiary could be a company which uses these data to achieve commercial goals or the Sustainable Development Goals (SDGs).

The Personal Information Management Systems (PIMS) proposed by the European Data Protection Supervisor (EDPS), the EU's independent data protection authority is an example of the data trust legal structure. PIMS allow individuals to manage their personal data in secure, local or online storage systems and share them when and with whom they choose (Personal Information Management System, 2016). If companies plan to use these private data to drive their business, they have to interact with PIMS. Data can be held in local-based storage such as users' laptops, smart phones, tablets etc. or cloud-based storage which is maintained by online service providers or specialized cloud-based PIMS providers. In some PIMS models, third parties (public or private entities) enter as new actors in the data management ecosystem as trust service providers, who build mutual trust mainly between users and service providers, by being identity providers and custodians, facilitating authorization mechanisms and enabling the traceability of personal data and of operations performed on them (European Data Protection Supervisor, 2016).

4.4 Technological Trends

Increasing IoT Standardization

The total installed base of IoT connected devices is projected to amount to 75.44 billion worldwide by 2025, a fivefold increase since 2015 (Statista Research Department, 2016). Obviously, the market of smart home devices will also grow bigger in the upcoming years, and the device's ability to work well with other devices will be an important factor that influences user experience. Imagining a consumer purchases a lamp from Philips Hue but it is not interoperable with Amazon's smart home system (Alexa) he already has, it will be disappointing that (s)he cannot switch it on and off by talking to Amazon Echo. Though recent smart home devices tend to work across multiple systems, they are not supportive for all systems and have various setup processes.

Therefore, Apple, Google, and Amazon are teaming up to develop an open-source smart home standard that's meant to ensure that devices work together, make the development of new devices easier, and keep everything secure in the process (Kastrenakes, 2019). Once this standard arrives, consumers will be more confident to try different devices at home with simple setup and control. On manufactures' side, they may even use the same set of parameters in a common feature, which means the data collected can also be in a consistent format. This potential will remove a technical barrier in data sharing or exchanging mechanism of collaborative data economy.

Summary 4

The trends depict a future where immense data will be generated through individual's increased daily interactions with their smart home appliances. These data can be shared with small companies or startups to empower rapid innovation and break up the data monopoly of giant companies. But individual users are anxious about the misuse of their personal data, especially when data will flow among different enterprises. Thus, a system, which can establish a mutual trust, will be needed to foster data sharing while protect users' rights of personal data.

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System Prototype

This chapter describes the concept of a data donation system based on trend scanning. I mapped out roles of all possible stakeholders and their interconnected relationships in transferring data. It was evaluated by experts with rich experience of data-driven design. Several VSD methods were integrated in evaluation sessions, where new insights pop up. In the end of this chapter, you will find the second iteration of the data donation system.

5.1 Data Donation System

Design Goal

The main purpose of designing a Data Donation System is to steer users' data toward people who can make a meaningful use of them and help users to get more control over their personal data at the same time. The system will protect users' rights on personal data by establishing mutual trust between stakeholders.

Inspired by PIMS in the previous chapter, I present a future vision that each citizen will have a private account at the Personal Data Bank which is a digital infrastructure supervised by governments or international non-profit organizations. Personal data can be temporarily stored here and shared to other individuals or entities for use with the consent of account owners. While 'Personal Data Bank' lays a base of trust in the system, the remaining questions are: Where are the data from? And who deserves the data donated by users?

To answer above questions, the Data Donation App is inserted in the system. It plays a pivotal role to bridge the gap between data subjects and data receivers. As showed in the picture (figure 4, on the next page), designers from data receivers' side will post what data are in need to drive their project on the App. From data subjects' side, users will see all the posts on the App, then they may be touched by some projects and decide to donate data to them. If so, the App will be authorized to help users retrieve these data from corresponding data holders, which are companies that collect data through their products or services of data subjects' usage. Because GDPR legitimize users' right of data portability (there might be other similar policies or regulations in the future), the companies have to send required data to users' Personal Data Bank account for private storage and use.

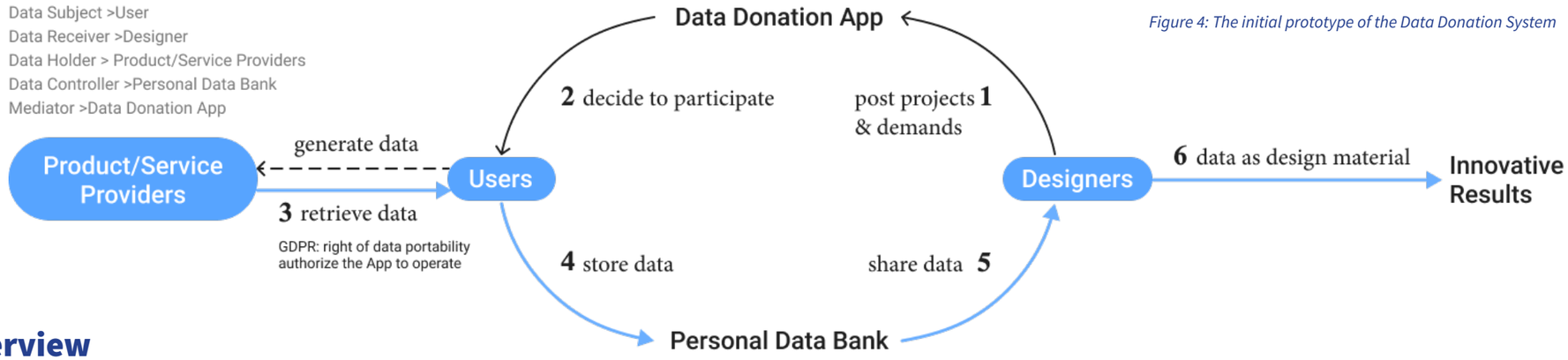

Figure 4: The initial prototype of the Data Donation System

5.2 Expert Interview

5.2.1 Setup

Value oriented semi-structured interviews are set up by using the initial prototype of the Data Donation System as a probe, which elicits experts' fresh ideas and concerns stemming from their professional practice in data-driven design.

All interviews had to be conducted online due to the Covid-19 pandemic. I organized the interview content on slides (appendix A) and sent them to experts as a PDF file before the interview. Experts were suggested to look through the file in advance. If the Internet connection were unstable and unable to support screen share or video, the experts would be guided to continue the interview through voice call.

5.2.2 Participants

I invited 3 experts who have worked for data-driven design projects to participate in one-on-one interviews. Their educational backgrounds and work experience cover the fields of user experience (UX) design and research, data science and psychology. Compared with individual users, experts are more likely to showcase a system thinking, so they are more suitable for interviews that use an abstract system prototype as a probe. In addition, they can contribute thoughts not only from professional perspective but also users' perspective.

Participant's Profile

Expert 1: Eric
Job: Associate professor at TU/e and co-founder of a German start-up in UX
Background: Computer science, electrical engineering
Interests: Designing with data, human values and sustainability issues in design

Expert 2: Andrew
Job: Senior UX designer at Accenture Interactive
Background: Design for interaction, industrial design
Interests: Mobile solutions, user-centered design

Expert 3: Joyce
Job: UX researcher at Shutterfly, graduated from Carnegie Mellon University (CMU)
Background: Human-computer interaction (HCI), applied psychology, industrial design
Interests: Quantitative UX research, digital product design

5.2.3 Content

The interviews consisted of 5 stages and takes up about 45 minutes each. In the 'Warming Up' stage, a value scenario of a smart home with various appliances was presented in an info graphic with a short narrative. It helped experts to be immersed in the domain, thinking about what kind of data might be generated in such a home and how to get these data, if they are needed in a sustainable design project.

Then, I introduced the Data Donation System to the expert, which paved the way for the third stage that aims for evaluating the future vision of the Personal Data Bank. The next stage is more explorative. The expert was asked to recall how data were integrated to his or her design projects. With expert's elaboration, I gained the knowledge of data processing in practical work and the expert was well prepared for contributing ideas in the final stage. I intended to learn what the expert may want from users specifically and what he or she would provide to engage users in data donation, which is the reference for designing Data Donation App in the next chapter.

5.2.4 Analysis

With consent from the participants, I recorded each interview and transcribed the audio recordings into texts for analysis. The Context Mapping (cite) and the Grounded Theory (Birks & Mills, 2015) are main references that guide the author to process the qualitative data.

I read through whole transcripts line by line, selected the most significant quotes, and attached

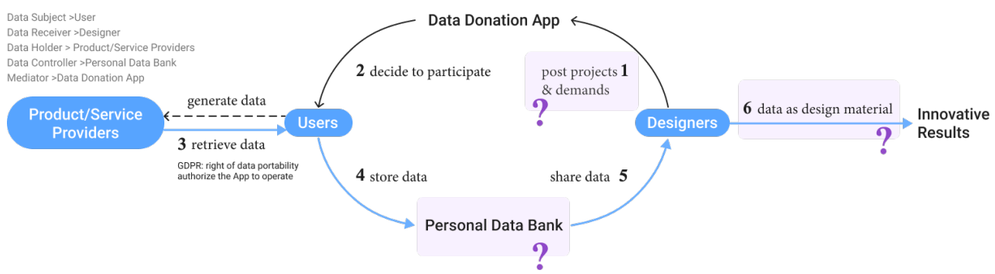

Figure 5: Main discussions happened in the "?" area

my interpretations to them. This process helped the me to merge information scattered in separate transcripts and form a comprehensive understanding of the interviews. Next step was coding, where selected pieces of data were attributed to sub-categories. Once the data, the interpretation and the sub-categories were all prepared, I clustered them into core categories, which add new content to the Data Donation System prototype.

5.3 Findings

Personal Data Bank represents a future of the digital society

Experts held a positive attitude toward the future vision of the Personal Data Bank. They perceived that individuals will have a demand to manage the data generated in daily life in the future, just like they manage their monetary assets today. Joyce pointed out:

"Your ownership or wealth is not only physical things, in fact, the data created in your life is also part of your personal wealth, and you need to manage it."

Therefore, experts thought that the Personal Data Bank would be a desirable and helpful infrastructure of the digital society in the future.

On the other hand, they also found the difficulties of implementation. Based on their rich experience of associating with users, Andrew and Joyce noticed that many people were not so tech savvy; they didn't have a good understanding of data; they were unclear about how data was generated, where it could be used and how to find value in it etc.. To make the Personal Data Bank really work, it is important for the government and some non-profit organizations to enrich public's understanding of data and raise awareness of their ownership of personal data. This is not an easy job to do and it may take a longer time than expected.

Designers' pain points in collecting data

This cluster depicts experts' reflection on current data collection approaches. It was quite common that they got used to search for data they need among public data sources or take data released by competitors as reference. However, these data sources didn't always meet all of their needs. Joyce argued:

"My first choice may be to find data from public data sources. At least, I can find some public overviews. Daily usage data may be hard to find, but the overview data should be there. … If I use data from a public database, I may get data with 30 dimensions, but ended up using only 1 dimension or none of them is what I want, then I have to look for data again."

If designers have no useful findings through above approach, they will collect specific data from scratch. In this case, Eric and Joyce considered to set up a data collection system at each household and they could monitor certain types of data through Apps or other digital tools. Andrew intended to build up a more controllable research space equipped with smart home devices and sensors as required. Though they could define the data they need for the project at the very beginning and then collect these data directly from users, the limitations on budget, labor and time in practice should be carefully taken into account as Andrew stated:

"But obviously it is a very high budget thing, because you have to set up such a space first, and integrate all the smart home devices and sensors. And of course, the process will be time-consuming, right? So this is a time-consuming and labor-intensive way to collect data."

Overall, experts felt that it was not an easy job to collect data, especially collecting daily usage data from users. They haven't thought up other ways that could be better.

Advantages of data donation

When the Data Donation System was introduced to experts, they generally held a positive view toward it because of the new opportunities it could bring to design. Data donation could provide an affordable access to usage data. It would be helpful for small innovation teams or academic research groups that may have no budget to purchase data. Joyce reflected her experience of designing a wearable product in a research group:

"I used to do some research on wearable devices in HCI lab, and we wanted to make a rough estimation of the amount of user's daily exercise steps for developing a new function. In fact, it was difficult for a research group to get these data, as we didn't have the budget to buy them, and the open source data on the Internet were probably inaccurate or scarce. So I think your concept will benefit those small innovation groups, or relatively academic-oriented research, it will be very helpful."

Getting data from the Data Donation System could save loads of time for designers, since the data have been generated already and sent by users voluntarily. Joyce pointed out:

"I don't have to worry about collecting data at all, because data has been generated by users already. All they have to do is retrieving data from the product providers and send them to me through 'Personal Data Bank'. So it helps me save a lot of time on tracking data collection. If without this system and I need household electricity usage data, I should teach users how to record data everyday. This is actually a very time-consuming thing."

Such advantages of the Data Donation System relieves Andrew's concerns for the limited budget and time assigned to the data collection period in design projects. Besides, Eric noted the potential of the Data Donation System to scale up data collection.

"This is something that I, as a researcher would not find very easy to scale up, at least. I mean, you can do one home, you can do two homes, but if you want to do 30 or 50 homes, then this is going to be very difficult. … I could imagine that this Data Donation App is more interesting on a larger scale. It could be that you are looking at hundreds of people instead of tens of people."

If designers receive data donated by users in a much larger scale, for example big data, there will be great changes in design process. In this case, Eric thought that the design would be less ethnography but involve more data science knowledge. It is interesting to explore data donation for designing with big data, but it is out of the scope of my research, which targets on designers who still apply many ethnographic methods, or to say qualitative techniques, in design.

Use donated data in design process

Though designers have access to users' data through their donation, they will never rely on it only. Instead, designers and their teams tend to combine data donation with other data collection approaches, including purchasing third-party data, seeking open data sources and conducting some user tests or experiments to get data.

Compared with data collected from scratch, experts thought donated data and data from other sources were still a bit more generic. Therefore, donated data could be taken as a reference and guide design directions in relatively early periods. Andrew elaborated:

"I personally think that if you get information from a reference or from this kind of database, it may still be a little bit generic and you probably learn something in a more general direction, but your own product must have a very specific scenario. I may use these donated data as a reference, but won't take them as a decisive factor in design. … Donated data can be processed in early period research. Once I come up with a primary concept of the product, I would like to conduct a usability testing with a prototype in a controlled environment, from which I will obtain data exactly related to my product. So, data donated by users and coming from other sources will not be used in validation."

Smart home data needs to be put into the context of use

This cluster depicts the connection between data and the context. In order to form an in-depth understanding of user behaviors when designers receive data from the Personal Data Bank, it is vital to learn about users' home settings where donated smart home data are generated. Eric gave an example:

"If someone donates data from an IoT system to his personal data bank, the designer needs to understand how his house looks like and where these devices are specially placed after receiving the data. Without this knowledge, the designer only gets sort of a surface level understanding of what is going on in the daily usage process."

Joyce also mentioned that contextual information such as 'the composition of the family and its geographic location' could help her figure out why the pattern of smart home data is like that. As all the experts stressed the indispensableness of the context of use, they held the view that designers should have access to users and their homes after they received smart home data through the Data Donation System. Joyce expected that designers could contact users, who donated their data to the projects, to participate in later on research, and she explained:

"If users are willing to, they can provide me with some following up possibilities, for example, he can choose to accept our interviews after data donation. If I find a special case later and want to understand what kind of living habits leads to such a special data pattern, I can have ways to contact him for an interview."

Designers Vs. Companies: data format

To help designers obtain the data that meet their requirements for design, I have already put forward the feature that designers could post what kinds of data they want users to donate on the Data Donation App. It is obvious that the requests for data varies in different projects. In the interviews, experts could not summarize a standard list of data types, but shared a common wish that they could be allowed to post data requests as detailed as possible. Andrew commented:

"From my perspective, the more detailed the better. For instance, the energy saving project. I would like to know the electricity data is generated during the day or at night. Any detail related to your project is worth considering."

Such a wish indicates that designers want to take control of the data at the beginning of the collection period, which ensures the data are in the right format when they receive them. If the Data Donation System could realize that, designers would receive more specific data donated by users in a more efficient way. However, users' data are generated on devices manufactured by different companies which have their own ways to record and store these data. Even users have the right to retrieve their data from these companies, the companies may not comply to send their data back in required formats. Eric explained his concerns:

"Let's say, the designer request on data about lighting. This is something comes from Philips systems or from other systems. The companies who store these data, umm, they deliver data. But because they are different companies, and they all have different formats. … Of course you can try to specify more and more and more. But at some point, I think you reach the boundary of what a commercial entity would like to comply with. … Legally they are obligated to give back users their personal data, but they are not obligated to send these data in a specific format with maybe a given structure or certain attributes, or certain additional semantics. Right?"

According to the trend research in Chapter 4, big companies are aligning with each other to establish an open-source smart home standard. This action may lead the industry to adopt a standard of recording and storing smart home data in the future. Nevertheless, efforts should still be put into easing the value tension between designers' detailed requests for data and companies' obligation of providing data in certain formats. This is a technical problem influencing the operation of the Data Donation System.

Designers Vs. Users: target users

Apart from defining what kinds of data are required, designers also have a criteria of who are qualified to donate their data. The same as finding target users to participate in user tests or interviews, designers want the data they receive through the Data Donation System are from target users. But, it is likely that some users may pretend to be the one designers expect for some reasons, such as obtaining the benefits after the donation. Andrew argued:

"On the one hand, you published criteria of target users because you want to get precise data; but on the other hand, they may pretend to match your criteria, so their data are inaccurate and probably disturb your decision. It's a tricky situation. It does happen, and it happens very often. … Actually, I encountered these kind of people in my work"

To avoid receiving data from un-targeted users and increase the accuracy or the reliability of donated data, experts suggested that the Data Donation System or the App have a feature of user filter.

"I will specify who are the target participants of my project at the beginning. The best solution is that the App can help me do segmentation, for example, a female, 22-30 years old. If the App can't do this, but provide me with such information, I can segment users by myself."

"I think your system should have an administration or a certification mechanism to ensure that the users are qualified to donate their data to a project."

Data visualization makes donated data as design material

According to experts' reflection on designing with data in their work, I found that there is gap between the donated data and the data used as design material. As what mentioned previously, it is hard for the Data Donation System to provide designers with data in the exact formats as they want, due to some technical issues. In this case, data filtering and some manipulations are necessarily needed to normalize the data. This job can be done by designers if they have enough knowledge of data science or can proficiently use data analysis tools. If not, designer can collaborate with data scientists or analysts in the team. Eric argued:

"That is something hopefully data scientists would do, but sometimes designers need to understand that this stuff happened before they get the data. So they need to be involved or they need to be told that this happened."

After the data are got into the right format or structure, they are still not very meaningful to designers. Therefore, the data should be converted into readable information, which is usually visualized as charts, dashboards. Experts found that the visualized data could be used as a design material. Andrew stated:

"If what you collected is raw data, you will always use a tool to do some analysis of it or make a simplified presentation, because now if you use Google analytics, or Adobe analytics, you won't really get through it with an Excel sheet, but you will always get a dashboard or a chart. That's basically what presented in front of me, as a designer. Then, I can really incorporate such processed data in my design."

Next, designers could gain some insights through analyzing the information presented on these info graphics and then tell a story, prove an assumption or find some design directions, etc

Extrinsic & Intrinsic motivations of donating data

This cluster comprises what experts think could motivate users to donate their data. According to the Self-Determination Theory (SDT; Deci & Ryan, 1985), human's motivations could be divided into two main types: extrinsic motivations and the intrinsic motivations. Extrinsic motivation is a drive to behave in certain ways based on external sources and it results in external rewards (Deci & Ryan, 1985). In contrast, intrinsic motivation refers to doing an activity simply for the enjoyment of the activity itself, rather than its instrumental value (Ryan & Deci, 2000).

Joyce was the only one who talked about motivations with the general structure of extrinsic and intrinsic types. Eric and Andrew's views could be taken as a complement of Joyce's response. I restructured the findings from the interviews by applying the self-determination model (figure 6), which divides extrinsic motivation into more specific categories and maps out all kinds of motivations according to the degree of self-determination behind. Since human is a complex being who is driven by multiple types motivations to behave, this model can help me better understand why users would like to donate data to design projects.

External regulation represents the least autonomous form of extrinsic motivation. The motivation under this category is exclusively external and regulated by compliance and external rewards and punishments. External rewards could be monetary, such as coupons, gift cards and etc. Joyce's idea of offering users a customized analysis of donated data together with energy-saving suggestions is also an example of external rewards.

The second type of extrinsic motivation is termed introjected regulation, in which the motivation is somewhat external because people behave with the feeling of pressure in order to avoid guilt or

Figure 6: The self-determination model. Extracted from Ryan and Deci (2000)

anxiety or to attain ego-enhancement or pride (Ryan & Deci, 2000). Joyce give the example:

"As your project just started, currently there is no participant. But you can tell users how many people donated their data to previously launched projects within the same domain. Let's say, 500 people have participated in projects about sustainability, and users may decide to donate their data to your energy-saving project because they tend to be the same as most of others. This is called the Bandwagon Effect in psychology."

A more self-determined form of motivation is identified regulation. In this level, the person can identify with the personal importance of a behavior and accept its regulation as his or her own (Ryan & Deci, 2000). Andrew thought that users would like to donate their data if they knew the project had a great impact on many other people. This is because some people may value helping others as an intrinsic life goal that satisfies the need of belonging and connectedness with others.

The most autonomous form of extrinsic motivation is integrated regulation. Though integrated forms of motivation share many qualities with intrinsic motivation, they are still extrinsic because behavior motivated by integrated regulation is done for its presumed instrumental value with respect to some outcome that is separate from the behavior, even though it is volitional and valued by the self (Ryan & Deci, 2000). Andrew deduced:

"Another possibility could be that the project itself is very encouraging. You mentioned blood donation, right? It is a very meaningful thing in real life, and that's why many people are willing to do it. So if your project also has a good meaning or is very encouraging, users will be more likely to participate in it."

Extrinsic Motivations of donating data	External Rgulation	Give users monetary rewards (tangible rewards)	Ex1
		Give users customized rewards based on their data (abstract rewards)	
	Introjected Regulation	Present a reliable profile of the project team	Ex2
		Do the same thing as what the majority have done	
	Identified Regulation	Projects have a good impact on other people	Ex3
	Integrated Regulation	Projects are very meaningful	Ex4
Intrinsic Motivations of donating data	Intrinsic Regulation	Users feel they can help themselves by data donation	In1
		Users feel a sense of accomplishment in data donation	

Figure 7: Possible motivations of donating data

The structure of this cluster is showed in the chart above (figure 7). One does not have to progress through each stage of internalization with respect to a particular regulation; indeed, one can initially adopt a new behavioral regulation at any point along this continuum depending upon prior experiences and situational factors (Ryan, 1995). If you are interested to know the examples of each kind of motivation given by the experts, please read the code manual in the appendix (B).

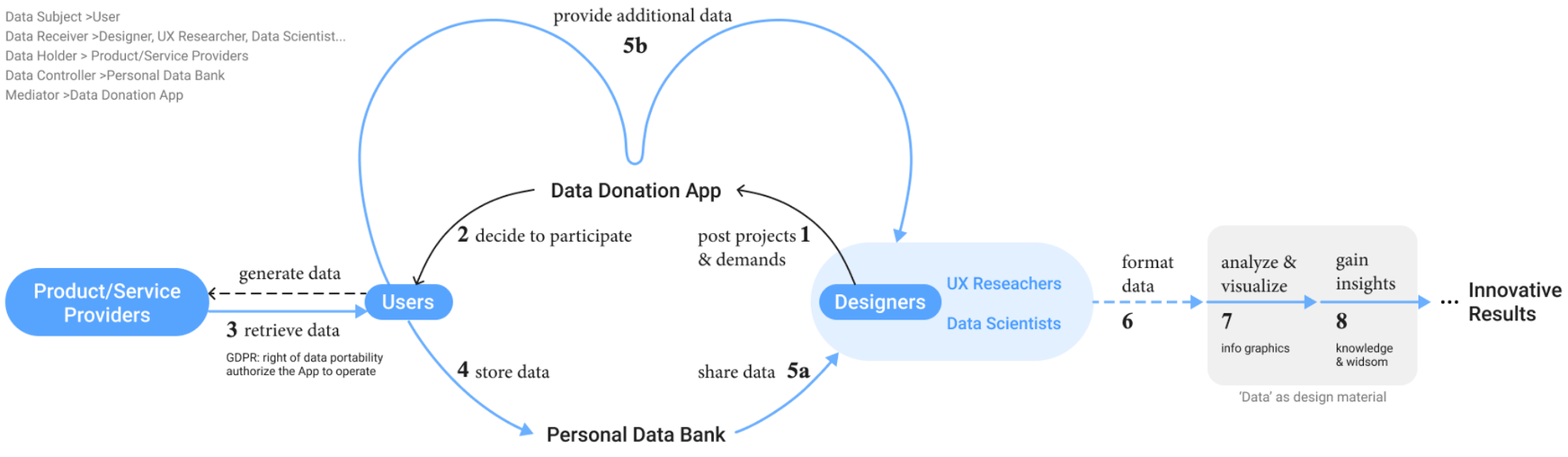

Figure 8: The 2nd version of the Data Donation System

5.4 Conclusion

After analyzing the transcripts of expert interviews, I visualized the key insights on the initial version of the Data Donation System:

• Since designers usually need additional information to understand the context, I added '5b' to the system. It means that the Data Donation App should open a channel which enables users to deliver contextual data or information to designers. Designers could post their requests for additional information along with the request for data, and users could decide whether to further engage in the design project after donating data. This mechanism increase the versatility of the system.

• Though my research focuses on 'designer', the role of other members of team cannot be ignored. After receiving data donated by users, designers may need the support from people who have professional knowledge and skills to analyze it. Therefore, I extended the scope of the data receiver to include UX researchers and data scientists at least.

• Donated data cannot be directly used as designer material. I replaced '6 data as design material' in the initial version with '6 format data', '7 analyze & visualize', '8 gain insights' to clearly present how data are processed and what is considered as design material.

The value tension between designers and companies toward data formats involves many technical issues that may affect the workings of the system. It is an interesting and challenging topic, but not in the scope of this research.

The value tension between designers and users toward the qualification of target users is worthy of attention in the design of the Data Donation App.

The findings of 'Extrinsic and Intrinsic motivation of donating data' form a basis for designing the interfaces of the Data Donation App in the next chapter.

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Product Prototype

The previous chapter had dropped a few hints to the design on product level. In this chapter, a prototype of the Data Donation App was made to elicit more thoughts from users, since it was easier for them to acquire the concept by interacting with a tangible thing than viewing the static and abstract system map only. Users' attitudes toward data donation served to another iteration of the Data Donation System.

Figure 9: The architecture of the Data Donation App

6.1 Data Donation App

Design Goal

The Data Donation App is the tangible touchpoint where users can enter the Data Donation System. Design projects and their respective requests for data should be appropriately presented in the app, while users should be effectively motivated to make a decision of donating data and clearly guided to take an action.

6.1.1 Architecture Design

Based on the insights gained from expert interviews, I built the architecture of the Data Donation App (figure 9). It comprises 3 parts: 'Projects', 'Activity' and 'Profile'. The 'Projects' part is like a shelf which contains different kinds of books – design projects with a theme meet with one of the Sustainable Development Goals (SDGs). The overview of each project includes a title, a theme tag, an image and a one-sentence introduction to grab users' attention. It also inform users about its status: 'on-going', 'completed' and 'waiting for data' (figure 10). Users can learn from the 'on-going' and 'completed' projects about what would happen after data donation and how many others have donated their data, which may encourage them to donate their data to the 'waiting for data' projects because they are more confident in the good result of their donation and willing to behave the same as other people.

Users are enabled to look through projects by their themes or status, but only the projects that define them as potential target users can be put on their "shelves". This measure is done by the app which matches the information users fill in the 'Profile' part with the requests of users' age, gender, location and etc. that designers have formulated. It could prevent some users who pretend to meet designers' requests from donating their data to the corresponding projects. In this way, designers could receive more reliable data from the system.

Users can find project 'details', 'requests' and 'benefits' inside the "books" by tapping on the image in the overview. It is designers and their teams that decide what should be displayed here to engage users in their projects by donating their data. The 'donate' button is always on the screen waiting for users who have made the decision of data donation to tap on it. Then, users will select such as what product they own and what data they have, which is a 'self-check' before they confirm their donation. Sometimes, there might be an invitation for participating in further research (e.g., an interview) attached to it and users decide whether to say yes or no at their sole discretion. Once the data donation is done, users will find this project at the 'Activity' part where the donation action is recorded and the project updates are highlighted.

6.1.2 User interface(UI) Design

Instead of drawing every single page by using Figma, a cloud-based design tool, I only drew the users interfaces of the 'Project' part. This is because the 'Project' part contains almost all the elements that can embody the relevant insights I got from expert interviews and these interfaces are enough to cover an interaction flow of data donation.

In order to build a prototype that is as close to the real scenario as possible, I put efforts into compiling a sample project (figure 10) with the goal of sustainable development and the need of smart home data from a project called FlipFlic: Makes Window Blinds Smart (Vinogradova, 2016). The original project description was edited as follows:

• The features of FlipFlic were remained the same. It is fitted with sensors and automatically responds to changing light and temperature. It has a built in battery that is constantly recharged with a solar panel, so it doesn't need power outlets. I put the original pictures here but shortened the text. (B1)

• I made the vision of this project more explicit and fit the goal of "climate action" as "help households save electricity and CO2 emissions". (B1)

• I emphasized the function of algorithms as "keep the amount of sunlight and heat at users' comfort level" (B1), which is a lead-in to the request of luminance, on/off state data from smart lights and temperature, wind speed data from smart air conditioners (B2). These assumptions were deduced from the original features of the FlipFlic. I intended to make them sound reasonable.

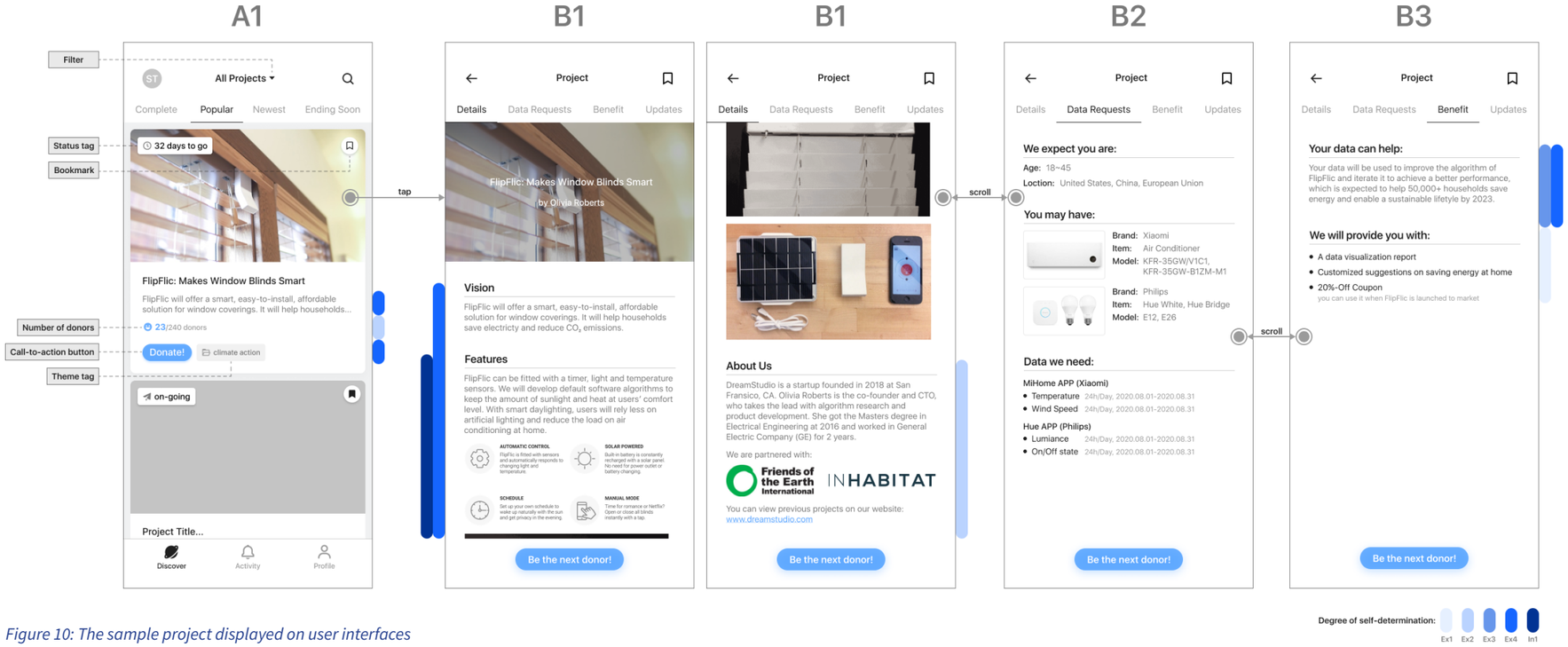

Figure 10: The sample project displayed on user interfaces

• I fabricated a name for the project team in 'About us' as "DreamStudio", together with an introduction of this startup, its green partners and a URL of their website where they showcased achievements (B1). According to experts interviews, a reliable profile of the team may be a factor that motivates users to donate their data.

• I stepped into DreamStudio designers' shoes to think about who would be the target data subjects, what products they should have and what kinds of data could be recorded by the products. I selected two popular smart home brands on the global market to reach a large amount of users. In the light of experts' demand for a detailed data request, I specified the product models under each brand and the corresponding data generated in that product with a time span. On the other hand, a clear display of these information would help users to judge whether they are eligible to donate data or not. (B2)

• I added possible benefits of donating data to FlipFlic project. 'Your data can help' could motivate users in a higher degree of self-determination than 'We will provide you with'. (B3)

• Before viewing the project in such a detailed level, users actually glance at its overview. The overview of each project is located at the first screen when users open the app. Users can scroll the screen up and down to find the project they might be interested in. (A1)

If users hit the blue button on the screen, a self-check list will pop up (C1). They should select the product they own and the data they are willing to donate. Then, the 'confirm' button will be activated. Once this button is hit, the app will check whether users select corresponding data to the product or not. If it is correct, users will be lead to the 'Activity' part and find this project there (D), meaning that they've successfully donated their data. Otherwise, they will get a feedback which tells them to re-select. In this same project, a pop-up screen (C2) was added between C1 and D, because I wanted users to experience the donation flow as full as possible. I assumed that designers from DreamStudio would do usability tests for FlipFlic, therefore they asked users who could donate their data to participate in the tests. Whatever users respond here won't impact on their donation, because they have been approved to donate data in the previous step.

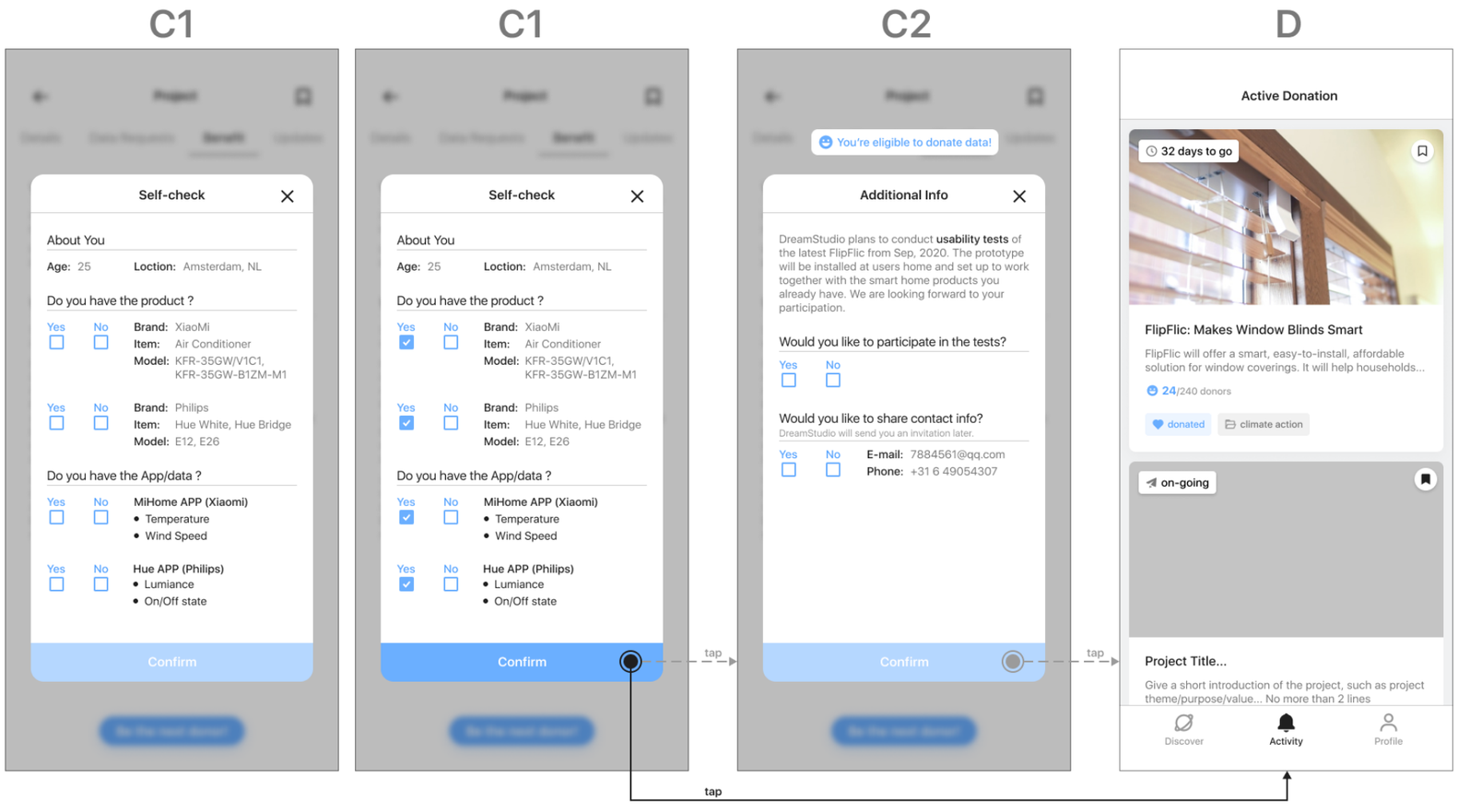

Figure 11: The pop-ups

6.2 User Testing

6.2.1 Setup

The user testing had to be carried out online during the pandemic. I prepared the test material on Maze.Design, where I could bring the clickable prototype made in Figma together with other preset blocks including open question, context screen, opinion scale and etc. to build a testing project (figure 12).

Then, I sent the testing link to participants and they were told to share the screen of the testing website during video call on Zoom. They could answer questions and do the task in a row. Meanwhile, I could follow their pace and observe their operation by viewing the same screen (figure 13). The test cost 40-50 minutes each.

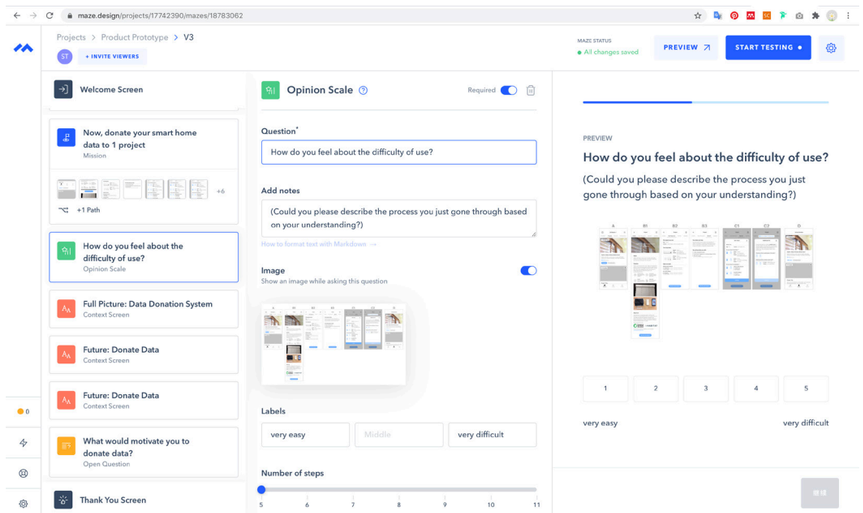

Figure 12: Maze.Design workspace

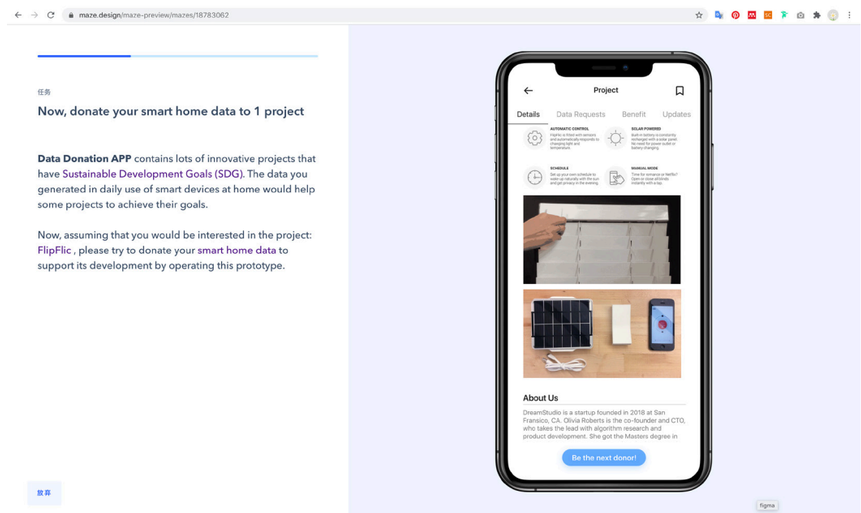

Figure 13: Maze.Design testing screen

6.2.2 Participants

I found 3 female participants and 3 male participants through social media. They live in United States, United Kingdom, Netherlands and China. Their age covers the three groups (20-24, 25-29,30-34). Half of them are using Xiaomi's products with MiHome app, which means they fit very well to the data requests of the sample project. Others who use Google Home and Amazon Alex system have more smart appliances at home, indicating that they have a more comprehensive understanding of smart home.

Name	Gender	Age	Location	What smart home appliances do you have?
Participant 1	F	25-29	CN	robot vacuum cleaner (MiHome app)
Participant 2	M	20-24	UK	smart light (MiHome app)
Participant 3	F	30-34	NL	smart light, intelligent switch, robot vacuum cleaner, surveillance cameras (Google Home app)
Participant 4	M	25-29	USA	smart light, temperature sensors, robot vacuum cleaner, intelligent locks, Amazon Echo (Amazon Alexa app)
Participant 5	F	20-24	CN	smart light, smart air conditioner, smart TV (Mi Home app)
Participant 6	M	20-24	USA	Intelligent switch (control light bulb, air conditioner, TV), Amazon Echo (Amazon Alexa app)

Figure 14: An overview of participants' background

6.2.3 Content

At the beginning of the test, participants took 3-5 minutes to recall a donation experience in their real life. They were instructed to describe this experience by answering questions including: (1) Who did you donate for? (2) What did you donate? (3) How did you achieve your donation? (4) What motivated you to donate?/Why did you donate? (5) What were your worries about such a donation? I wanted to deepen participants' identification with the donation scenario first. Thinking about what happened beforehand would help them to understand the new form of donation more easily.

Then, I proposed that they could donate their data generated during their daily interactions with their existing smart home devices to make some good things happen. It is just like donating money or other objects they mentioned. Next, they were asked to donate their smart home data to the sample project – FlipFlic. In this way, participants would gain real experience of donating data to a design project through their mobile phone by clicking on the prototype (figure 13), which unfolded a probable future before their eyes. During this task, participants were encouraged to speak out their thoughts. When they were stuck at some step or confused about some elements, I could give explanations right away. After the task, I asked how they felt about the difficulty of use and they could choose a degree of difficulty from 1 to 5. Though this test was not intended for the usability of the UI design, I wanted to ensure the UI didn't confuse participants or affect normal use at least. This was crucial for them to comprehend the data donation concept and answer the following questions in good quality.

In the next step, I presented the second version of the Data Donation System (figure 8) along with an introduction. The participants learned about why there would be a Data Donation System in the future and how the system would operate to accomplish a donation like what they experienced just now. At this stage, I asked similar questions compared to the beginning: (1) What would motivate you to donate data? (2) What are your worries about such kind of donation? In the end, the participants could compare data donation with their previous donations.

*The full content can be find in appendix (D).

6.2.4 Analysis

During the tests, I took notes (figure 16) by hand and recorded the audio. Notes helped me to reflect on what I've heard from participants, so that I could quickly analyze it in mind and paraphrase some of the answers to check whether I got what participants really meant. If not, I would ask several sub-questions before moving to the next session.

When finishing each test, I listened to the audio again, revised some notes and written down missed information after a 10 minutes break. I spent some time to review the notes of the first three tests and could summarize some commonalities. The unique views were well kept aside. Then, I started the last three tests with more confidence because I had a rough frame of participants' opinions in mind. Once all tests were done, I read through the notes to re-summarize common views and interpret unique but inspiring points.

Why use handwritten notes

Handwritten notes gave me more freedom than typing notes. I could use the space on paper to set topics apart. I could draw arrows to connect related topics and draw stars to mark pivotal moments. Besides, it was important to avoid the sound of typing interrupting the participants' speak and audio recording.

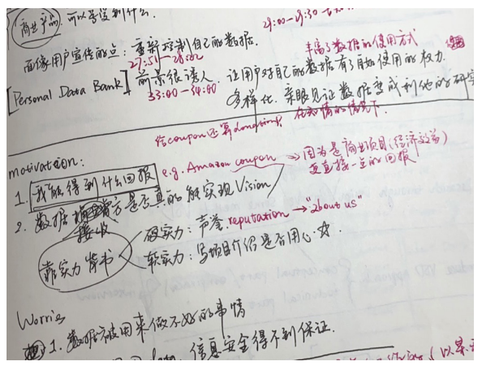

Figure 15: A small piece of handwritten notes taken in a user test.

6.3 Findings

Privacy concerns

When talking about data donation, participants considered the privacy issues at once. They recognized that by interpreting data, others could know about them, including things they didn't want others to know. They also worried about that data might be stolen in transfer and the safety of the Personal Data Bank where their donated data would be held. Among all participants, Participant 3 had an exceptionally strong awareness of protecting her data. Though she installed many smart devices at home, she tried to save the data recorded by these devices at local storage as much as possible instead of transferring all these data to cloud storage. She said that:

"On the one hand, smart home devices enables me to live an easier life. On the other hand, I have to accept the risks of privacy disclosure it brings about. Therefore, I always try to strike a balance between these two sides. I choose to save part of data at local storage to reduce risks, and I'm willing to accept the result that I cannot enjoy some services from the companies, like Google."

There was a similar concern in data donation. As participants were clear about the risks mentioned above, they would evaluate whether the project was worth the risks to support. Participant 4 felt quite relieved when he found the data requested by FlipFlic project was not privacy sensitive. He argued that:

"Like what you put in the App, If I were asked to provide data that doesn't contain much personal information such as the temperature, luminance, I would be more willing to give it out. I would be happy to see it helps the design of FlipFlic without the loss in privacy."

Treat commercial projects differently from charitable projects

In this research, I defined the data receivers were mainly from star-up companies. Therefore, the sample project was set to be commercial, which was noticed by all participants. They take donating data to support commercial projects differently from donating money or objects for charitable purpose.

They didn't care too much about returns from the receivers in previous experiences such as donating money to help cancerous person or earthquake victims. This was partly motivated by the ethics of doing good to the weak. But for commercial projects, participants thought that no matter what the startup companies designed, they intended to make money out of it; if they donated data to support them, they would expected some direct benefits in return. Since they understood that small companies didn't have enough budgets to purchase data (compared to big companies, they were 'the weak'), the monetary reward in the form of coupon was quite acceptable by participants.

Regulation on the data receivers

Like worrying about whether the donations would be used as promised by charities or non-profit institutions, participants worried about whether the startup companies would really use their data as what they described in the app. Four participants suggested to involve a regulatory authority in the Data Donation System to administrate the behaviors of the data receivers, such as preventing them from using the data in another project that were not approved by the data donors.

Besides, participants thought the authentication of the data receivers was also important. Participant 1 stated that:

"If the app or the platform could authenticate the profile of the startups, block fraud information, I would trust more in what they said. Based on that, I can really be motivated to donate data by their vision or the benefits they will provide."

Set up more entrances to the App

Participant 4 asked inspiring questions about How could users know the Data Donation App? How could users know some projects need their data in design? These questions relates to the words "engage users" in the research questions in a more bottom level.

The user testing was based on the fact that participants had download the Data Donation App and registered as a user of it. Then, I studied what in the app or in the system would motivate them to donate their data. However, the first step should be engaging them in the Data Donation App. Even they download the app, they would not open it in a very high frequency. Thus, they are not aware that certain kinds of data they own could help some design projects, and just miss the opportunity to exercise their right of using data as they want.

It is necessary to add more entrances to the App. For example, broadcast ads on YouTube to attract people to download the App in the first period. Then, the existing users of the app can share the link of the projects that ask for data through social media together with an automatic generated poster, which could be another potential entrance.

6.4 Conclusion

Overall, participants were willing to take control of the personal data usage in the form of donating data through the system I designed. They expected the future when they could witness their own data being used to accomplish something meaningful to themselves, to other people and to society. Meantime, the trustworthiness of the Data Donation System in the perspective of protecting them from fraudulent data requests and increasing the security of data transfer and storage would affect their decision of donating data more essentially, compared to the motivations summarized in Chapter 5 and embodied in the UI design.

After analyzing the notes taken during user tests, I iterated the Data Donation System to the third version (figure 16):

• I added an arrow from users to the Data Donation App, presenting the entrances that could reach out to users more obviously.

• Regulation of the data receivers is a way to protect users values in data donation.

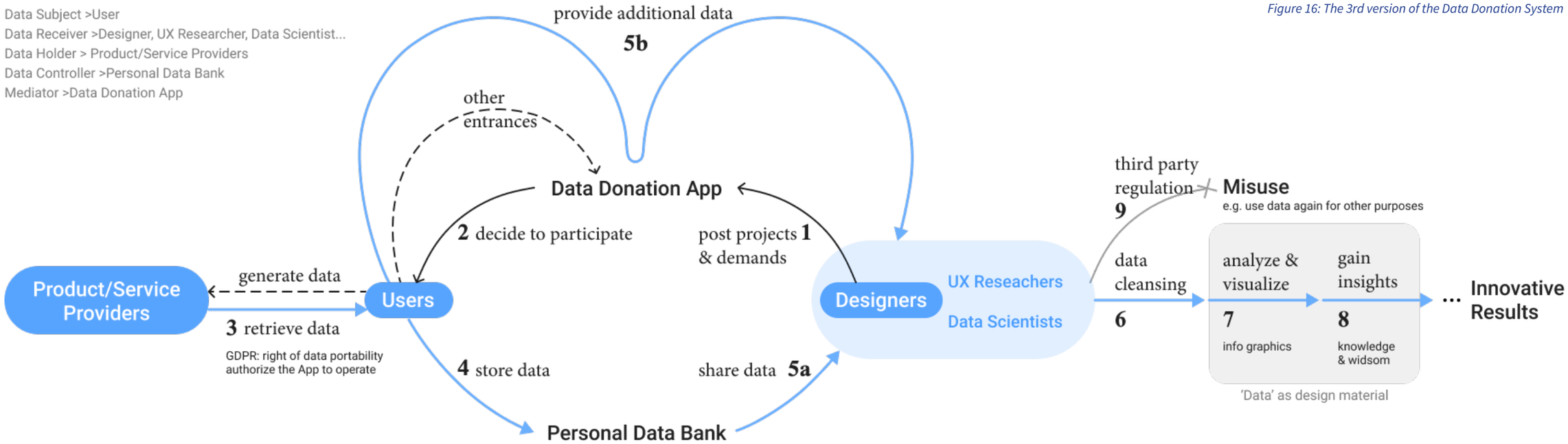

Figure 16: The 3rd version of the Data Donation System

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Discussion

7.1 Reflection

7.1.1 Literature

The DIKW theory laid a foundation for me to understand how data are processed to different forms. What I found from expert interviews (how designers used data in their work) was consistent with the theory. It stressed the starting point where data could be taken as a new kind of design material.

Verbeek's theories about mediating role of technology led me to pay attention to how the data receivers and the data subjects would interact with data donation 'technology'. From the expert interviews and user tests, I did notice the unexpected use cases of the Data Donation System. The first one is that the data subjects may pretend to meet the requirements of donating data; the second one is that the information posted by the data receivers on the app may not be authenticate. The former affects the quality of the data donated to the data receivers; the latter interferes the decision-making of donating data and may hurt users, if the data receivers have bad intensions of collecting and using these data.

7.1.2 Method

VSD methods were really helpful in dealing with values from different stakeholders in building a complex system. Value scenarios and value sketch methods were applied in preparing the interview material for experts. The audio transcripts were analyzed to create a value-oriented manual, which could be viewed by other researchers who study related topics such as data sharing, designing with data, user engagement and etc.

Value tension played an important role in iterating the Data Donation System. For example, after the expert interviews, I knew designers would define their target data donors to ensure they could receive the data as they really want, but some users might pretend to be eligible for reasons like they want to get certain benefits from donating data. Therefore, I added a feature to the Data Donation App that could filter out unqualified users to some extent. Besides, I think this method helped me to take the responsibility of the moral aspects of the Data Donation System by looking into the conflicts of different stakeholders and finding the unintended mediation roles of the system.

The iterative characteristic of the tripartite methodology fitted to the research process, where I came up with the concept of the data donation system after conceptual investigation and then improved this concept for two times through expert interview and user testing in empirical investigation phase. What not mentioned in Chapter 3 is that this process could also be compatible with the methodology called Research Through Design (RtD). In RtD, researchers generate new knowledge by understanding the current state and then suggesting an improved future state in the form of a design (Zimmerman & Forlizzi, 2014). I designed the initial version of the Data Donation System to elicit insights from experts.

Based on the deepened understandings of the situation, I improved the design of this system and got ideas of design in product level. Then, the updated system and the interactive prototype of the Data Donation App within it were applied to elicit insights from the data subjects. It led to one more improvement of the system and a more comprehensive understanding about donating data to design projects.

7.2 Contribution

It is not uncommon to see real cases of data donation in healthcare field. Patients are engaged in medical research by giving out their data to the doctors or healthcare researchers. They can help themselves from doing so, for example, getting a more precise or personalized treatment. Such an intrinsic motivation is highly self-determined, therefore motivating them to donate data is not very difficult.

This research investigated into other domains where data donation rarely happens. Though I chose the domain of using smart home data to design sustainable products which inherently have good purpose, the design projects are varied and users may not have strong intrinsic motivations of giving out their data to them. On the other hand, startup companies need data to drive the design project but are lack of budget to purchase data or collecting data from scratch on their own. Gaining data from donation is an affordable choice for them.

This research proposed a solution to help startup companies to engage users who have the data they need in their design through the Data Donation System. The system balances the values of both the data receivers (designers and their teams from startups) and the data subjects (users who generated data on existing products). It also takes the values of the data holders (big companies that provide smart products to users) into account. This balance is fundamental to enhance users rights of controlling the usage of their own data and it sets up a trustable environment for data flowing among these parties. The findings of users' motivations of donating data through this research could be taken as a reference by the data receivers when they are in the practice of posting information on the Data Donation App in the future.

7.3 Limitation

This research didn't include the technological investigation of the VSD tripartite methodology. I spotted the technical issue when analyzing the value tension between the data receivers who want to make detailed request of data format and the data holders who are not obligated to provide the data in specific required formats. As a result, the data receivers have to sacrifice some time and efforts in normalizing the data they receive from the Data Donation System. However, I could not come up with a wise solution to solve this issue with the knowledge I had.

Theoretically speaking, I should conduct at least 10 interviews with detailed coding to build a grounded theory. In this research I only interviewed 3 experts, because it was hard to contact suitable interviewees during the Covid-19 pandemic. Another reason was that the grounded theory method would generate huge data (it could be considered as a drawback of this method), and the project schedule didn't allow me to spend too much time to analyzing them. In order to guarantee that the interviews could bring me about information from multiple perspectives, I carefully chose the interviewees who had varied knowledge backgrounds.

The sample project used in the design of user interfaces was compiled from another project. I tried to make the story consistent logically, but it was still not a real project that needs smart home data generated from other products to support design. As a result, I sometimes felt difficult to give a convincing answer to participants' questions about the sample project itself during user testing, such as "why does FlipFlic needs my data? How will the data being used?". If I have more time, I may find a related real project and invite the designers of the project team to create the content (of project details, data requests and benefits).

7.4 Recommendation

This research has found two interesting directions to investigate in the future. The first one is how to help designers and their teams to save time and effort in normalizing data they receive from the data donation system. Solving this problem can make this system more helpful to the data receivers in the perspective of increasing the efficiency of transforming raw data to the form that can be used as design material. Another direction is how to effectively regulate data receivers to use data as what they informed to data subjects on the app. This will reduce users' worries of data misuse, which is a factor hinder them from donating data.

Conclusion

This research explored the mechanism of engaging users in donating their data to design projects. It was scoped down to look into the domain of sustainable design projects that need to be driven by smart home data, which made it easier to apply VSD methodology in eliciting values from multiple stakeholders. The iterative process deepened and completed the understanding of how data subjects, data receivers and data holders would interact with the Data Donation System. The last iteration of the system stroke a balance between their needs derived from different values they cared. It could enable the individuals to take autonomy on their data through donation with less worries by establishing a trustworthy environment. It could empower the startup companies to develop their design projects by providing an affordable, reliable and efficient data source.

The findings from this research can guide designers and their teams to motivate users to donate their data that are needed in their design projects. Besides, new knowledge has been added to the understanding of data donation outside the domain of healthcare research, which was less studied before.

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