How to Implement and Teach Responsible Design

The Development of a Framework of Responsible Design Practice

Y. Mai

University of Twente

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Student number: s2449684

First Supervisor: dr. S.Borsci

Second Supervisor: dr.ir. A.P.van den Beukel

Faculty of Behavioural, Management and Social Sciences

Abstract

Responsible Design is a design approach to tackling pressing societal and environmental challenges that dwindle sustainable development. Currently, to our knowledge, frameworks of Responsible Design are mainly focused on supporting and driving developers in generating ideas of design, but such frameworks do not explain how to operationalize responsible design in practice in terms of design activities, methods, skills and tools. Responsible designers need a guide to better align their practice with the philosophy of Responsible Design. Moreover, in light of the profound influence engineers and designers bring in societal transformation (Haug, 2017), and the goal shared by the United Nation (UN) community of bolstering sustainable development (UNESCO, 2014), educational institutions should seek ways to incorporate Responsible Design in their programmes to nurture social responsibility and abilities of future developers and innovators. A methodological framework of design practice should also support such an educational transformation, especially in the aspect of practical design skills. The present research aims to explore how the concept of Responsible Design could be operationalized with regard to design practice required to execute the concept, as well as the methods, skills and tools used therein. To this end, we first conducted a systematic literature review and we attempted to build an initial model of Responsible Design practice. Then we applied this model to a case study on a new digital service for responsible shared mobility, and we used the lessons learned by this applied case to refine the model of Responsible Design practice. Furthermore, we reviewed the two bachelor programs at the University of Twente mapping where and how Responsible design is embedded in education. Finally, in line with our model of Responsible Design practice, we proposed opportunities and recommendations such as encouraging more active involvement of stakeholders, multidisciplinary collaboration and summative assessments of design outcomes, to enhance the presence of Responsible Design in the education offered at UT.

Contents

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1 Introduction

1.1 The Concept of Responsible Design

Responsible Design (RD) is an approach, a way of thinking about and tackling societal challenges in research or in practice (Cipolla & Bartholo, 2014). The term "Responsible" describes a characteristic of the design implemented by the designers (Ashour, 2020); this denotes the ability, desire and conduct in terms of responding to the needs of and challenges faced by society (Ashour, 2020; Eggink, Ozkaramanli, Zaga, & Liberati, 2020). According to Eggink et al. (2020), "Design" in the context of RD can represent both a process (i.e., the act of designing) and the outcome of that process (i.e., the designed artefact or intervention). They propose that it is possible to look at RD from three perspectives: designing in a socially responsible manner by organizing the design process in a responsible way. Designing in such a way that the responsibility of the user is addressed in or with the product but also designing in such a way that the outcome (product or service) encompasses social responsibility. From these perspectives, the meaning of responsibility is respectively expressed as i) a socially responsible manner shown in organizing the design process, ii) the shared responsibility between the designer and the user that is shaped by free interpretation of the exact use of the designed artifact by the user; and iii) the social responsibility embedded in the design outcome. The design outcome — be it a policy, service, space, system or product, should be good for people, for the environment and bring positive social change (Bissett-Johnson & Radcliffe, 2019; Eggink et al., 2020). In line with that, RD entails the requirement for designers to consider a holistic set of societal values including justice, health, inclusiveness, equality and sharing, while recognizing and anticipating the consequences of their decisions and actions (e.g., Melles, de Vere, & Misic, 2011).

From a historical point of view, the roots of RD can be traced back to the late 1960s and early 1970s when a Nordic design student group, the Scandinavian Design Students'

Organization (SDO) proposed a movement for redirecting the purpose and priority of design to assuming social responsibility (Lie, 2016). The main goal of the SDO was to reposition design as a toolkit more than a discipline to create products that designers could use to answer the urgent challenges of society (Lie, 2016). For the SDO designers should be active promoters of design practices and solutions to social issues, for instance, accessibility and quality of life for people with disabilities. The Scandinavian movement also incubated various design philosophies and approaches like participatory design, co-design, social design, and ecological design (Lie, 2016). The movement progressed in line with the proposal by Victor Papanek (1971), who first argued for the socially responsible design of products and community infrastructures in the field of industrial design. In his significant work (Papanek, 1971), *Design for the Real World: Human Ecology and Social Change*, he suggested that *responsible design* means designing for people's needs rather than their wants aiming at supporting the needs of vulnerable people such as the elderly, the poor, and people with disability (Margolin & Margolin, 2002). Papanek's original agenda for socially responsible design reflected a drastic division between the social and the commercial design as he harshly criticized the market economy, and was not immune to criticism. Revisiting Papanek's work, Margolin and Margolin (2002) proposed to see RD as a socially-oriented approach of design as opposed to commercial design:

> "Papanek pits socially responsible designers against a commercial market [...]. Papanek argues that socially responsible designers must organize their interventions outside the mainstream market, yet he gives little guidance as to how this might be done. We believe that many professionals share the goals of designers who want to do socially responsible work, and therefore we propose that both designers and helping professionals find ways to work together" (Margolin & Margolin, p. 27).

The Scandinavian tradition of design, as well as Papanek's proposals of socially responsible design, inspired designers up until today by changing the way practitioners intended the design and opened several pathways that designers are currently exploring. This is also because, during the eighties, the increased interest in environmental issues associated with services for consumers and companies sparked the philosophy of green design that put energy and recycling problems at its core (Koo, 2016). Concurrently, the idea of socially oriented design became of interest from the commercial point of view so that in the nineties, the concept of eco-design got traction by reflecting the idea of design products with a minimal ecological impact through its product life cycle. Nowadays, *sustainable design*, the refined modern form of eco-design which enlarges the scope of design considerations to societal matters, has gained much momentum (Melles, de Vere, & Misic, 2011).

All these eco and green design approaches could be captured or are at least associated under the umbrella of RD which includes, also, the ideas of inclusive design, design for social innovation, transformation design etc. (Cipolla & Bartholo, 2014; Koo, 2016). Moreover, depending on which viewpoint of RD is taken, some newer design philosophies and approaches such as Dilemma driven design (DDD) and Value sensitive design (VSD) come into the picture (Eggink et al., 2020). DDD aims to address dilemmas by design, ranging from self dilemmas like individuals resisting temptation on a diet, to environmental dilemmas like humans restraining the exploitation and use of non-renewable resources (Ozkaramanli, 2017; Ozkaramanli, Özcan, & Desmet, 2017). VSD is a process of designing artifacts around human ethical values, that is, *what is important* to people in their lives, and *what is right* and *what is not right*, with a focus on ethics and morality (Friedman, Hendry, & Borning, 2017).

RD being a multifaceted approach of design to social challenges it can be implemented in multiple ways, through different approaches and using various methods, depending on the purpose of the design and the intentions of the designer. In the present work,

RD as term is used to identify the common umbrella for all the approaches that put emphasis on design as a way to promote social responsibility, environmental and societal changes, serving as a guidepost for how today and future designs should affect and change society. Overall, RD is a way that designers assume social responsibility by design practice.

1.2 Responsible Design in Contemporary Times

The notion of the "social responsibility" of designers and responsible decision-making is strongly echoed by the 17 Sustainable Development Goals (SDG) and 169 targets for social change proposed by the United Nations in 2015 (United Nations (UN), 2015). The UN vision is built upon the idea of eradicating poverty, fight inequality and tackle climate change until the year 2030, towards the ultimate objective of realizing sustainable development and sustainability (United Nations, 2015). To achieve sustainability, sustainable design is required. According to Ashour (2020), the term "sustainable" is used to refer to design solutions. Creating sustainable design solutions is a critical requirement for, an indispensable component of, and a means of responsible design. Designers should have the intention and attitude towards sustainability right from the beginning, continuously reflecting on their design deliverables' economic, environmental and social implications during the process of creating a sustainable solution (Ashour, 2020). To ensure the responsible results being what people and society need, Hernandez and Goñi (2020) further extended the design process by incorporating in it three elements representative of responsibility: distributed agencies, pertinence and transparency.

i) Distributed agencies means that the involvement of different stakeholders such as universities, local authorities, business firms and active negotiation among the parties for actions, benefits, burdens and properties. Besides, end-users should play a role as active agents because they can determine how the design will impact others in the world by their decisions.

ii) Pertinence is what makes designers and engineers think if what they are designing is worth it. It is a matter of not only assessing the good and harm of a product that will reach beyond the economic area, but also deciding who and when to decide whether a product is pertinent.

iii) Transparency is related to honest communication of how the artifact works, how safe it is, what the potential impacts it can produce are, and in general all the information required to make an informed decision regarding the ownership and the use of the artefact.

RD now has gained attention also in the education field, as indicated by Ashour (2020) that inculcating responsible attitude of designers through transforming design education is imperative. Currently educational programs for design-related majors are designed to mainly target tangible (technical or aesthetic) aspects of products, traditional production and consumption that are driven by the commercial market priorities. But this focus should be re-directed to the consequences of the decision making during the design process and the potential impact of products on humans and society (Bissett-Johnson & Radcliffe, 2019; Cipolla & Bartholo, 2014; Koo, 2016). As suggested by de Vere, Bissett-Johnson and Thong (2009), design education should be re-aligned to incorporate social responsibility and sustainability to foster a responsible mindset and ethical awareness in engineering and design students in response to environmental and social challenges for two reasons. First, integrating sustainability and design responsibility in education is necessary in line with the UN “Decade of Education in Sustainable Development” initiative (2005-2014) and introduction of the 17 SDGs principles which are nowadays considered key drivers for the education at European level (UNESCO, 2014; United Nations, 2015). Second, as engineers and designers have a central role in driving innovation and societal transformation (Haug, 2017), their way of

thinking and designing products and services is going to affect the future world and society (Koo, 2016).

A paradigm shift in design education is hence needed, to direct business and practitioners' attention to human values, the fulfilment of the needs of individuals and communities, and realization of quality of life (de Vere, Bissett-Johnson, & Thong, 2009; Koo, 2016). Such a paradigm change should begin in education where the future creators of things are nurtured (Cipolla & Bartholo, 2014). It is noteworthy that some educational institutions have started to answer the call for sustainable and responsible design. Examples include the Faculty of Behavioural, Management and Social Sciences (BMS) of University of Twente that has explicitly embraced the UN's SDGs (see Utwente, 2019); and the Faculty of Industrial Design Engineering of Delft University of Technology that has incorporated the teaching of various RD-related methods in the course context (e.g., for a course program example, see Stappers, Sleeswijk, & van der Lugt, 2007).

1.3 Aim of the Current Study

The current study aims to explore current models and build a methodological framework to support the implementation of RD in practice and in education. To achieve this goal, we performed a systematic literature review using the approach of Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA; Liberati et al., 2009) to identify the commonalities among various RD-oriented practices in terms of design principles, as well as effective methods and tools to operationalize these principles. We used the results of the review to build an initial model ("Framework of Responsible Design Practice, FRDP) for implementing RD in terms of methods and tools. Moreover, we applied the framework as a checklist to reviewing a case provided by the project Stad-up — a local government's pursuit of mobility innovation in the City of Enschede, the Netherlands. Firstly, we used the FRDP to review the design solution and the methods used in the case study. This enabled us to reflect

on what was done, what should have been done in the case study. Secondly, we modified the FRDP by incorporating lessons learned from the case study. Finally, we adopted the revised FRDP to review the engineering and design education in the University of Twente, attempting to identify gaps concerning RD education and propose recommendations on better incorporating this concept in relevant bachelor programs.

2 Systematic Literature Review

2.1 Methodology

2.1.1 Study Design

Following PRISMA methodology, we systematically reviewed the articles adopting approaches and methods associated with RD over the last 10 years.

2.1.2 Research Questions

The main research question for the literature review is: what are the most commonly used methods, skills or tools to implement RD in literature (e.g., design projects and research)?

2.1.3 Eligibility Criteria

Our inclusion criteria for records are:

(1) the studies belong to domains such as industrial product or service, interaction and experience with digital systems and human factors;

(2) introduced and provided an explanation of RD in the title, abstract, keywords or main text, rather than only mentioned it in the reference list;

(3) included approaches, methods, skills or tools to implement RD, or described procedures of applying responsible design in design projects.

We excluded records that fall outside the abovementioned design domains.

2.1.4 Search Strategy

Records were retrieved from Web of Science, ProQuest, JSTOR and Scopus electronic databases. We used the Boolean operators (AND/OR) to combine the keywords responsible design, industr*, interaction, product, service, digital and experience. We searched only for English language articles. For complete information about the methods, see the PRISMA checklist in Appendix A.

2.2 Results

As shown in Figure 1, a total of 179 items were retrieved through databases searches with 87 additions from the Google Scholar search. After removing 44 duplicates, the remaining 135 records were screened by title and abstract for eligibility, resulting in 48 records. The remaining 48 records were then reviewed in full to look for those mentioning methods or approaches to RD in practice and education. The final list comprised 31 records.

Figure 1

Literature Review Flow Diagram

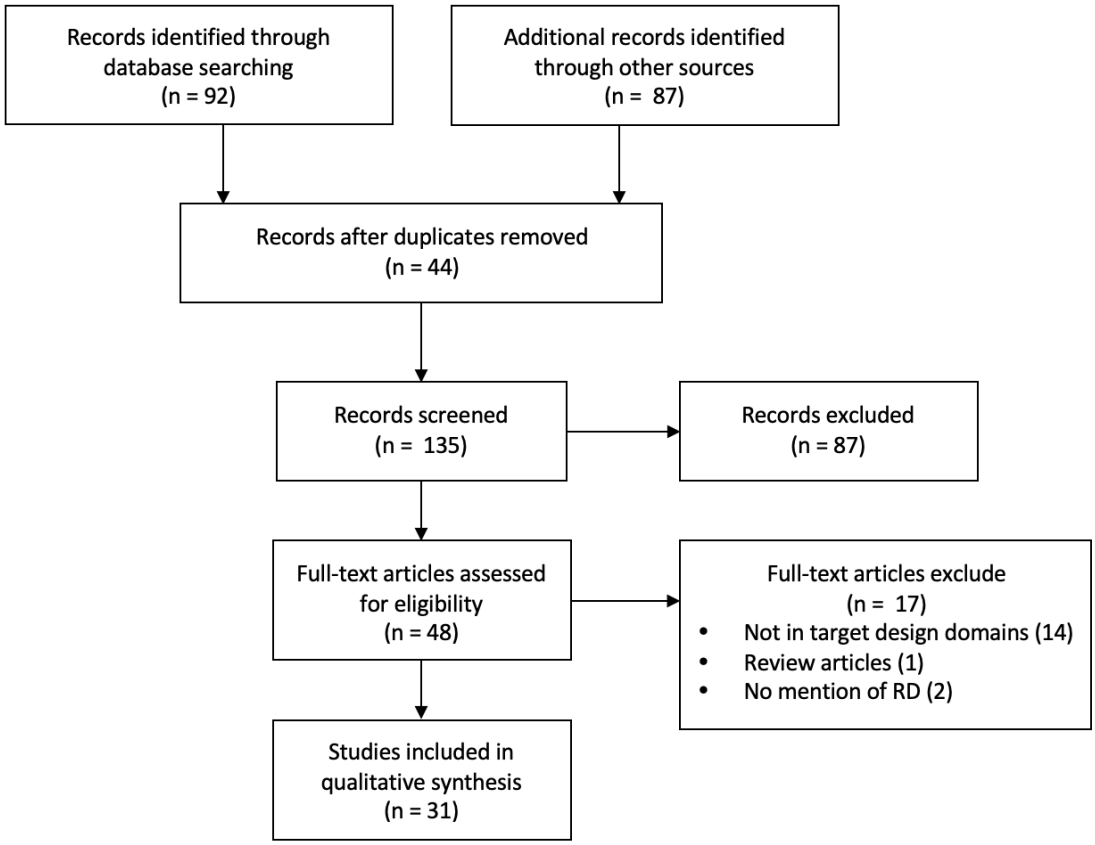


Table 1 presents the subject areas and goal of each study. Notably, Socially responsible design (100% of items in the review), Design education (32.3%) and sustainable design/sustainability (32.3%) are the most prevalent subject areas related to the umbrella term "Responsible Design", followed by ethics (22.6%), Design for Development (DfD) (19.4%), and Design for the community (19.4%). For the full list, see Table B1 in Appendix B.

Table 1

General Information of Each Study Including Authors

Study number	Subject area	Goal of design
Ashour, 2020 [1]	• Ethics • Sustainable design/sustainability • Sustainable Design education	• Define principles and/or methods applicable independent from the type of products or domain
Bennett et al., 2017 [2]	• Social innovation • (Responsible) design education	• Health design for kids

Bissett-Johnson & Radcliffe, 2019 [3]	• DfD • Sustainable design/sustainability • (Sustainable) design education	• Design for development • Define principles and/or methods applicable independent from the type of products or domain
Brown, 2010 [4]	• Design thinking • Social innovation	• Design for social innovation • Define principles and/or methods applicable independent from the type of products or domain
Caruso & Frankel, 2010 [5]	• Design thinking	• Define principles and/or methods applicable independent from the type of products or domain
Cipolla & Bartholo, 2014 [6]	• Empathy • Social innovation • (Responsible) Design education	• Improve the quality of campus life
Devecchi & Guerrini, 2017 [7]	• Empathy • Relational aesthetics • Design thinking	• Define principles and/or methods applicable independent from the type of products or domain
Dutta, 2019 [8]	• DfD • DfC • DfGD • Social justice and equality	• Design for communities • Design for the developing/design for development (DfD) • Design for social change
Eggink et al., 2020 [9]	-	• Define principles and/or methods applicable independent from the type of products or domain
Eggink, 2020 [10]	• Future scenario development • (Responsible) Design education	• Future design interventions
Grimpe et al., 2014 [11]	• RRI • Ethics	• Design HCI under RRI agenda
Haug, 2017 [12]	• Ethics • Sustainable design/sustainability • Social justice and equality • (Sustainable) design education	• Define principles and/or methods applicable independent from the type of products or domain
Hernandez & Goñi, 2020 [13]	-	• Build a framework od extended design process • Define principles and/or methods applicable independent from the type of products or domain
Jochems, 2017 [14]	• RRI • Ethics	• Telehealth and society
Klein & Phillips, 2011 [15]	• Sustainable design/sustainability	• Define principles and/or methods applicable independent from the type of products or domain
Kuure & Miettinen, 2017 [16]	• DfD • DfC • Social design	• Improve the livelihood of local communities in underdeveloped areas

Leeuwis et al., 2018 [17]	• Social innovation • Citizen science • DfC	• Design a virtual citizen science platforms (EVOCAs)
Letens, 2015 [18]	• SRD • Sustainable design/sustainability • Lean product development	• Design environmentally sustainable industrial products
Lie, 2016 [19]	• SRD • Sustainable design/sustainability • Design education	• Define principles and/or methods applicable independent from the type of products or domain
Lutnćs, 2017 [20]	• SRD • Responsible creativity • Systems-oriented design • Ethics • (Responsible) Design education	• Design sustainable systems (system design)
McMahon & Bhamra, 2017 [21]	• SRD • Sustainable design/sustainability • (Sustainable) design education	• Define principles and/or methods applicable independent from the type of products or domain
Melles et al., 2011 [22]	• SRD • DfD • Sustainable design/sustainability • Social design	• Design for development • Define principles and/or methods applicable independent from the type of products or domain
Mink et al., 2015 [23]	• SRD • DfD	• Design for vulnerable population in underdeveloped areas
Morley & Floridi, 2020 [24]	• SRD • Ethics • Empowerment	• Health care and mHealth
Nascimento & lvora, 2013 [25]	• SRD	• Opening up technologies to the social
Peters, 2020 [26]	• Wellbeing-supportive design	• Design for wellbeing using Positive technology and computing
Ranisch et al., 2020 [27]	• SRD • Ethics	• Health care and mHealth
Rodil, 2017 [28]	• SRD • DfC • Systems design	• Digital learning (apps) (digitalization of intangible cultural heritage)
Rose, 2016 [29]	• SRD • DfC • DfD • Social justice and equality	• Design for vulnerable population in underdeveloped areas
Smith & Karthaus, 2012 [30]	• SRD • DfC	• Improve the livelihood of local communities in underdeveloped areas

Sorice & Donlan, 2015 [31]	• SRD • Social innovation • Empathy • Sustainable design/sustainability • Design thinking	• Develop an environmental conservation incentive program	

Note. SRD = Socially Responsible Design; DfC = Design for communities; DfD = Design for the developing/design for development; ICT = Information and technological communication; HCI = Human-Computer Interaction; RRI = Responsible Research and Innovation.

Table 2 shows the approaches and methods related to the implementation of RD as mentioned by each of the 31 studies. Participatory design is the most common methodology (48.4%), followed by a multidisciplinary approach (35.5%), co-design (32.3%), Formative assessments (iterations) (29.0%), and Human-Centred Design (HCD; 18.8%). See the other mentioned approaches from Table B2 in Appendix B.

Twenty studies (64.5%) mention design methods, however, in only ten of these studies (ID: 2, 6, 8, 10, 15, 20, 21, 23, 29, 31), authors reported information regarding how the methods were applied in the design process by case study (e.g., a real-world project, assignment in a design course) while the remaining ten items (ID: 4, 5, 9, 11, 16, 22, 25-28, 30) simply name the methods for RD but do not elaborate on the relevant activities and procedures. Popular methods that are named at least three times include IDEO HCD Toolkits (IDEO, 2015), multidisciplinary collaboration (e.g., via workshop), interviews and participant observation (see Table B3 in Appendix B). The other eleven studies provide a definition of RD and its principles without mentioning any method or tool.

Table 2

Identified Responsible Design Approaches and Methods in Each Study

Study ID	Design approach mentioned	Method(s)/tool(s) mentioned	Describe design process	Notes

			No	Yes
Ashour, 2020 [1]	• Multidisciplinary approach and Interdisciplinary knowledge synthesis • Sustainable design • Design ethics/ethical design • Formative assessments (iterations)			
Bennett et al., 2017 [2]	• Social innovation • Play	• Generative play		×
Bissett-Johnson & Radcliffe, 2019 [3]	• HCD • Appropriate technology • Culturally sensitive design • Multidisciplinary approach and Interdisciplinary knowledge synthesis • Sustainable design			
Brown, 2010 [4]	• HCD • Design thinking • Multidisciplinary approach and Interdisciplinary knowledge synthesis • Social innovation	• IDEO HCD Toolkit (e.g., brief, observation, shadowing, brainstorming)	×	
Caruso & Frankel, 2010 [5]	• HCD • Co-design • Participatory design • Multidisciplinary approach and Interdisciplinary knowledge synthesis • Social model of design practice	• IDEO HCD Toolkit • Liz Sanders' MakeTools	×	
Cipolla & Bartholo, 2014 [6]	• HCD • Emphatic design • Co-design • Participatory Design • Regenerative design • Transformation design • Social model of design practice • Dialogical approach • Social design • Social innovation • Multidisciplinary approach and	• IDEO HCD Toolkit		×

	Interdisciplinary knowledge synthesis • Service design • Formative assessments (iterations)				
Devecchi & Guerrini, 2017 [7]	• HCD • Emphatic design • Participatory design • Co-design • Transformation design • Phenomenological framework • Design thinking • Formative assessments (iterations)				
Dutta, 2019 [8]	• Co-design • Participatory design • Formative assessments (iterations)	• Participant observation • In-depth interviews • Focus groups		×	Adopt Participatory design and Co-design
Eggink et al., 2020 [9]	• Multidisciplinary approach and Interdisciplinary knowledge synthesis • Participatory design • VSD Co-design • Inclusive design • Open Script design • Critical design • Speculative design • Dilemma driven design	• Co-creating Responsible Design workshop	×		
Eggink, 2020 [10]	• Participatory design • Scenario-based design • Open script design • Future scenario development (philosophy of technology + UCD)	• Future scenario development • The Product Impact Tool		×	
Grimpe et al., 2014 [11]	• Participatory design • VSD • Critical design • UCD • RRI	• Ethical framework (e.g., Kelly et al., 2013) • Stakeholder collaboration • Situated user-designer communication • Anticipatory governance	×		Under the RRI agenda
Haug, 2017 [12]	• Design ethics/ethical design				

Hernandez & Goñi, 2020 [13]	• Sustainable design • Inclusive design • Participatory design • Social design • Value-sensitive design • Formative assessments (iterations)			
Jochems, 2017 [14]	• RRI • Formative assessments (iterations)			
Klein & Phillips, 2011 [15]	• Sustainable design	• Biomimicry • Life cycle analysis (LCA)		×
Kuure & Miettinen, 2017 [16]	• Co-design • Participatory design • Capability approach • Design ethnography • Social design • Service design	• Co-design workshops • Co-design exhibitions • Participatory (fieldwork) observation • Interviews	×	
Leeuwis et al., 2018 [17]	• Multidisciplinary approach and Interdisciplinary knowledge synthesis • Social innovation			
Letens, 2015 [18]	• Lean product development approach • Eco-design			
Lie, 2016 [19]	• Social design • Co-design • Participatory design • Multidisciplinary approach and Interdisciplinary knowledge synthesis • Sustainable design • Design activism			
Lutnćs, 2017 [20]	• Critical reflection • Systems-oriented design	• Reflective inquiry		×
McMahon & Bhamra, 2017 [21]	• Multidisciplinary approach and Interdisciplinary knowledge synthesis • Formative assessments (iterations)	• Multidisciplinary collaborative learning		×
Melles et al., 2011 [22]	• HCD • Participatory design • Co-design • Multidisciplinary approach and	• IDEO HCD Toolkits	×	

	Interdisciplinary knowledge synthesis • Eco-design • Inclusive design • Social design • Sustainable design			
Mink et al., 2015 [23]	• Capability approach	• A semi-structured interview approach: Opportunity Detection Kit for qualitative inquiry		×
Morley & Floridi, 2020 [24]	• Digital medical gaze • Empowerment • Digital companions			
Nascimento & lvora, 2013 [25]	• Multidisciplinary approach and Interdisciplinary knowledge synthesis • Participatory design • Appropriate technology • Eco-design • Capability approach • Universal design • Empowerment • Postconstructivisms • Social design	• Participation of citizens and communities (participation methods)	×	
Peters, 2020 [26]	• Wellbeing-supportive design • Formative assessments (iterations)	• Service Design Toolkit • IDEO HCD Toolkit • Zig Zag Creativity Card Deck • Tarot Cards of Tech • The Dilemma Co-Exploration Toolkit	×	
Ranisch et al., 2020 [27]	• Design ethics/ethical design	• Ethical design framework for contact tracing apps • Assessment framework for contact tracing apps	×	
Rodil, 2017 [28]	• Participatory design • Systems design	• Participatory approach • Design ethnography: contextual dialogues	×	
Rose, 2016 [29]	• Social model of design practice • VSD • HCD • Design ethnography • Formative assessments (iterations)	Design ethnography: • Participant observation (in the form of transit-use and ride-alongs with participants) • Semi-structured group interview		×

		• Video diaries		
Smith & Karthaus, 2012 [30]	• HCD • Participatory design • Co-design • Transformation design	Participatory approach: • Tools that help local communities to claim their right to development (e.g., SDI tools)	×	
Sorice & Donlan, 2015 [31]	• HCD • Empathic approach • Design ethnography • Participatory design • Co-design • Social innovation • Design ethnography • Design thinking	• IDEO HCD Toolkit (e.g., ethnography, co-design and rapid prototyping)		×

Note. VSD = Value-Sensitive Design; HCD = Human-Centred Design; SI = Social innovation/design for social innovation; UCD = User-Centred Design.

2.3 Discussion of the Literature Review

The results of the present review indicate that only one-third of the papers explain the specific, but different, design practice to implement RD, and the methods used vary to a certain degree. On the one hand, this suggests a gap in responsible design literature, as a common driver or set of principles for the operationalization of RD is missing. As suggested by Cipolla and Bartholo (2014) RD thinking is still being explored in different modalities and this probably reflects the need for flexible approaches required to enable creativity and dynamic problem-solving during the design processes of RD solutions (Hill, 1998).

It seems that RD (Table 1; Table B1 in Appendix B), is mainly intended by all of the items in our review as a process that aims to bring a solution to a societal issue i.e., “Socially Responsible”. Moreover, in 32.3% of the articles RD is also intended as an activity (including education) that emphasizes the importance of responsible or sustainable design from the industrial and education point of view. “Sustainable design/sustainability” is considered an important aspect of RD in 32.3% of the cases in which authors are stressing the importance of

the sustainability of the design solutions. Moreover, RD researchers and practitioners call for more attention to “Ethical design/Ethics” (22.6%) in the design process. For an overview of the identified subject areas of RD literature, see Table B1 in Appendix B.

The current findings indicate that common methodological approaches do exist to support RD proposition but mainly in terms of ideas generation that can help designers to develop a solution during the design phases. In particular, RD practitioners seem to focus on: Participatory design (PD), Co-design (intended as methods of the Human-Centred Design), Multidisciplinary approach and Formative assessments (iterations), as reported in Table B2 in Appendix B.

. PD emphasizes that the stakeholders, especially end-users, are treated as experts to bring in their knowledge into the research and design process (Steen, 2011). Co-design accentuates “collective creativity” in the ideation/creation phase of design (Sanders, 2008; Steen, 2011).

In terms of practical methods and tools, IDEO HCD Toolkits (IDEO, 2015) is the most frequently mentioned approach by RD practitioners (30% of items in the review; Table B3 in Appendix B). The Toolkits comprise methods for HCD with three categories (i.e., inspiration, ideation and implementation) corresponding to the three major phases of research-and-design practice. Among the other methods, also relatively common are interviews (20%; including semi-structured interview, group interview and in-depth interview), design ethnography (20%; including participant observation and video diaries), and co-creation/co-design workshops (20%).

2.3.1 Models for Implementing Responsible Design

Nine models, five being theoretical and four practical, are presented in the literature as the most relevant to implement Socially Responsible Design or RD. They are presented here in order of publication date. Firstly, we introduce the theoretical ones:

- The "social model" proposed by Margolin and Margolin (2002) — it was developed on the ground of social work, and it calls for multidisciplinary work in collaboration with the "client system" of designing a product that satisfies a human need (Caruso & Frankel, 2010). The framework represents a six-step problem-solving process — engagement, assessment, planning, implementation, evaluation, and termination, supported by collaboration between the designer and clients (Caruso & Frankel, 2010; Margolin & Margolin, 2002).
- The model of Responsible Research and Innovation (RRI) — it encompasses four traditional conceptual dimensions: anticipation, reflexivity, inclusion and responsiveness and two emerging ones: sustainability and care (Grimpe, Hartswood, & Jirotka, 2014; Burget, Bardone, & Pedaste, 2017). It mainly targets the design of technology-related policies.
- The model termed Teaching Interdisciplinary Environmental Responsibility (TIER) that was introduced by Bohem (2015) — it is intended as an interdisciplinary pedagogical model for sustainable design and teaching environmental responsibility. It was built upon the principles of sustainable design, which are Respect for wisdom of natural systems, Respect for people, Respect for place, Respect for the cycle of life, Respect for energy and natural resources, and Respect for process (Jones, 2008).
- An organization-based model proposed by Koo (2016) — it incorporates corporate social responsibility (CSR) and designers' Socially responsible design (SRD) decision-making.
- A design process model, Extended Design Process, that was introduced by Hernandez and Goñi (2020) — it is based on the Double-Diamond Model developed by the Design Council in 2011. The double diamond represents a

solution-oriented design process consisting of four common stages: Discover, Define, Develop and Deliver (Design Council, 2011). Hernandez and Goñi (2020) upgraded it with additional three basic elements of RD: transparency, pertinence and distributed agencies. These elements aim to ensure that responsibility is incorporated in the design process, which facilitates practitioners to develop responsible outcomes.

The aforementioned five frameworks orient towards action and can be adopted to guide RD at a conceptual level (Hernandez & Goñi, 2020), yet explanations are lacking regarding practical methods to use that correspond to each element, section or stage within these models.

As an extension to the five conceptual models of RD described above, four practical frameworks were developed to guide RD projects and they are described here in order of publication:

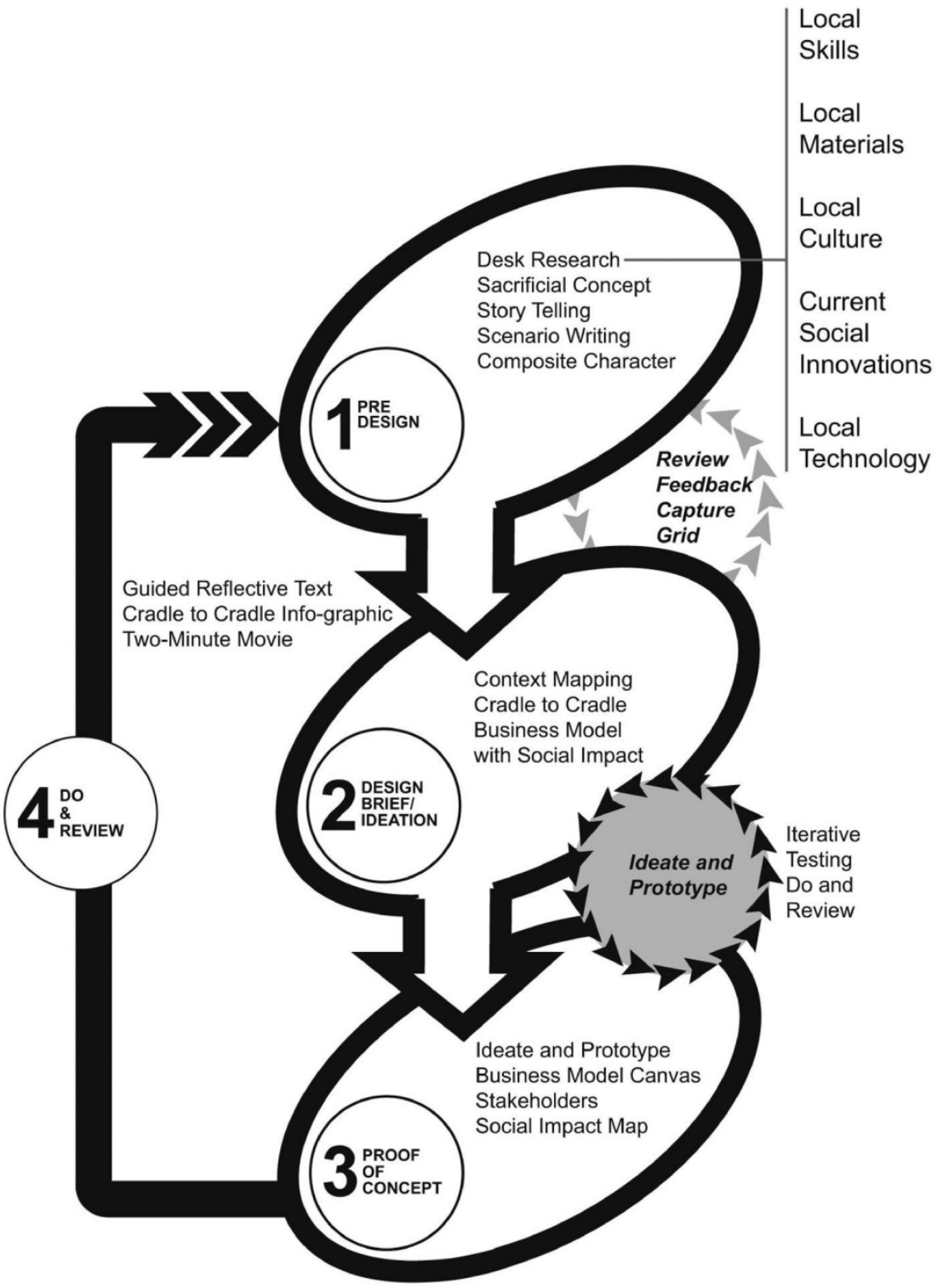
- IDEO's Human-Centred Design model — H (Hear), C (Create) and D (Deliver), is operationalized in their newest field guide which contains 57 methods and tools to implement HCD (IDEO, 2015). H means to first co-explore and co-define the problem to be solved with all stakeholders. Methods in this stage include using "How Might We" question to frame the design challenge, group interview, ethnography, and generative tools to eliciting user thoughts. C is the process of ideating, which can be executed with methods from "How Might We" insight statements, to using frameworks like Journey Map, then to brainstorming and co-creation sessions; D is a concrete phase where the designed solutions are delivered.
- The DDD framework consists of three main activities — dilemma identification (discovery), definition, and application, with each activity being executed with supporting design methods or tools such as Emotion Capture Card procedure, Co-

exploration toolkit and Framework of dilemmas for analysing and defining dilemmas (Ozkaramanli, 2017; Ozkaramanli et al., 2017).

- The Value-Sensitive Design process model is employed in the design of technology in order to account for human values in a principled and systematic fashion (Friedman, Kahn, & Borning, 2002). Its essence is the Tripartite Methodology that underscores the iteration of conceptual, empirical and technological investigations of values. Friedman, Hendry and Borning (2017) identified some developed methods in VSD such as value dams and flows, envisioning cards, value-oriented semi-structured interviews, and value sketches. Each method serves a particular purpose and design rationale and can be used for each of the three types of investigation.
- The Locale model was proposed by Bissett-Johnson and Radcliffe (2019) in an attempt to renew engineering pedagogy, and it was applied in courses. This model based on definitions of sustainable development and Margolin and Margolin's (2002) "social model". It focuses on four aspects of appropriateness: socio-cultural, techno-sphere, economic, and environmental. They organized the engineering design process into Pre-design, Decision brief/Ideation, Proof of concept and Do & Review activities each with different methods and tools (Figure 2).

Figure 2

Design Methods and Tools as Learning Activities in the Locale Model (Bissett-Johnson & Radcliffe, 2019)



These four practical frameworks however do not inform how the methods are related to the principles of RD. Accordingly, efforts to combine the strengths of conceptual models and practical frameworks are needed to connect theory and practice.

Based on the insights from the present literature review, we are proposing in the next section to connect conceptual and practical frameworks to inform practices for applying RD principles in the design process. To do that we created a new framework of responsible design practice (FRDP) which map methods onto principles of RD in different stages of design.

2.3.2 A Working Framework of Responsible Design Practice

To summarise our findings so far, RD is mainly intended as a process of design management guided by principles to co-design solutions with end-users and stakeholders with the aim of improving society e.g., reduce consumption of energy etc. In this sense, when a product is designed with a responsible approach and has a responsible intent it should produce a responsible solution. Nevertheless, currently, it is hard to understand how to operationalise in practice the responsible intent by a coherent set of methods that can support RD.

To build the skeleton of the tentative FRDP that can help practitioners to operationalise the key principles of RD we first list down the key principles of RD building upon the principles of (socially) responsible design proposed by Grimpe et al. (2014): Reflexivity and context, Participation, Value-sensitivity and Awareness of societal consequences. Moreover, we complemented the list with two supplementary principles from Steen's (2011) HCD — Multidisciplinary collaboration and Formative assessments. These two aspects of implementing RD are acknowledged respectively by 35.5% and 32.3% of all the articles reviewed. We also illustrated the practical meaning of each principle with core practices recognized in the literature.

To inform designers on how to execute each principle and make the FRDP actionable, we extrapolated design aids from methods and tools described in the IDEO's guide (2015) as well

as from the literature reviewed. Here we intended design aids, in line with Ozkaramanli (2017), as all the methods, tools, techniques, strategies and toolkits that can be used by designers in different stages of the product development cycle to conduct user research, generate ideas and test their solutions. We then added examples of matching design aids to each RD principle based on the design aid's purpose and design rationale. See Table 3 for the framework, and Table B4 in Appendix B for descriptions of the design aids and key references.

Table 3

Framework of Responsible Design Practice (FRDP)

Category	Principle	Explanation	Design aids
Intention of the solution	Reflexivity & context	Be reflexive on attitudes, values, assumptions and beliefs underlying research and design development, in relation to the users' context, and especially the political, moral, and ethical aspects (Burget at al., 2017; Steen, 2011). Be aware of the broader systemic context of the 'problem' that is to be addressed (Grimpe et al., 2014). Localize the situation: situate the problem, the user and artifact in the local context (Bissett-Johnson & Radcliffe, 2019). Consider the "systemic context" of the problem to be addressed (e.g., Grimpe et al., 2014).	- Define the Brief: Frame your challenge - Ethnography (e.g., participant observation, video diaries) - Contextual inquiry - Contextmapping - Future scenario development - Participatory scenario generation - Service Design Toolkit - Reflective Inquiry via GIGA Mapping - The Product Impact Tool
	Value-sensitivity	Respect human values and critically evaluate the investigation process and design outcome against the values.	Define the Brief: Frame your challenge - Ethnography (e.g., Participant observation, Video diaries; Guided tour)

	a) Have the right intention: have ethical awareness and sense of responsibility of contributing to sustainability (Haug, 2017). Critically explore societal values, including justice, health, inclusiveness, equality, sharing and civil liberties; reflect on those values throughout the entire design project (Ashour, 2020). b) Have empathy: designers should have the motivation and perform activities to empathize with people and identify their unmet needs. A way for this is getting insights into people's everyday experiences and trying to experience their life in context (Cipolla & Bartholo, 2014).	- Interview (one-on-one or group interview) - Contextmapping - Card sorting - Role playing - Liz Sanders' MakeTools - Service Design Toolkit
Awareness of societal consequences	Be capable to foresee the impacts of the design in relation to the social, humanity, and the environment. a) Anticipate impacts of design: anticipate the impacts of the design outcome on society concerning what societal changes, both positive and negative, may occur; and what effects will the design have on the environment (e.g., Ashour, 2020; Grimpe et al., 2014). b) Ponder the pertinence of design: designers should think about if what they are designing is worth it, in relation to issues like security, privacy, safety, and ownership (Hernandez & Goñi, 2020).	- Define the Brief: Frame your challenge - Future scenario development - Participatory scenario generation - Tarot Cards of Tech - Reflective Inquiry via GIGA Mapping

Approach of generative design	Formative assessments	Within a project of product development, conduct research, generating solutions and assessing solutions in an iterative and formative manner (IDEO, 2015; Steen, 2011).	- Role playing - Rapid prototyping and Iterate
	Active participation	At the core of the Participatory design approach, the participation of stakeholders is valuable as a channel for bringing ideals of social responsibility into the design (Grimpe et al., 2014). a) Distributed agencies: involve many different stakeholders who come together to negotiate actions, benefits, burdens and properties (Hernandez & Goñi, 2020). Additionally, the end users should be deemed as active agents who can determine how the design will impact others in the world by their decisions. (Hernandez & Goñi, 2020). b) Participatory approach throughout: have all stakeholders (people of various groups from the local community) directly and actively involved in each stage — from the early problem framing stage to the design development process (Grimpe et al., 2014). Define and redefine the brief together with users and stakeholders (Cipolla & Bartholo, 2014). Have the “everyday people” from the local community Co-design in the creation phase, jointly exploring and creating things with the design team (Sanders & Stappers, 2008; Steen, 2011).	- Define the Brief - Ethnography (e.g., Participant observation, Video diaries; Guided Tour) - Interview (one-on-one or group interview) - Contextmapping - Co-design workshop/Co-creation session - Generative play - Participatory scenario generation - Zig Zag Creativity Card Deck - Liz Sanders’ MakeTools - Service Design Toolkit

Project organisation	Multidisciplinary collaboration	Build a team of members from different disciplines, organize multidisciplinary teamwork and research agenda (Eggink et al., 2020; IDEO, 2015; McMahon & Bhamra, 2017; Steen, 2011).	- Define the Brief - Co-design workshop/Co-creation session

The six principles reported in Table 3 (Reflexivity and context, Value-sensitivity, Awareness of societal consequences, Active participation, Formative assessments, and Multidisciplinary collaboration) could be intended as key components of an RD project and represents the structure of the FRDP.

Looking at these principles that we identified and originally summarized from literature, however, it seems that the main focus of RD is on ensuring the incorporation of ethical values (Value sensitivity) and awareness of the context (Reflexivity & context) in the design process while little attention is placed on the assessment phase of the solution itself.

Impact of RD projects on society and on individuals seems to be mainly considered something that is already incorporated in the process of design thanks to the participatory approach, nevertheless less attention seems to be placed by practitioners on aspects associated with the *quality in use* that should be monitored during and after the release of the product or service. Quality in use is usually determined by the usability and user experience of a product or service (ISO/IEC, 2011). According to ISO 9241-11 (2018), usability is defined as "the extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use"; user experience is user's perceptions and responses resulting from the use and/or anticipated use of it. Although 9 of the 31 articles reviewed (ID 1, 6, 7, 8, 13, 14, 21, 26, 29) discuss the importance of iterative assessments (Table B2 in Appendix B), all these items are mainly referring to the iterative generation, testing and validation of ideas *during* the product ideation and implementation phases, that is, formative assessments, as indicated by Cipolla and

Bartholo (2014, p.89):"Methodologically it (human-centred design) means...making things visible, managing risk through prototyping, trying things out and *iterating ideas* rapidly."

However, formative assessment is not equal to the *summative* assessment performed *after* the product or service is put into use by consumers, and none of the reviewed articles included in our review discusses the importance of assessment of RD. The tacit point behind RD seems to be that the design approach aims to systematize and bring responsibility in the design process with the assumption that this will bring to design products with a responsible intent, e.g., to benefit people and society. However, without a systematic way of assessing and following up RD solutions in the real world, it is hard to understand if the intent of the RD solutions is fulfilled.

FRDP (Table 3) could be intended as a practical guide for design practitioners and a checklist of design activities and methods to support the implementation of RD principles, with the advantages compared to previous models of offering practical insights on how to connect design aids (i.e., methods, tools, and techniques) to the RD principles. The FRDP can be considered a re-organization of the prior knowledge on RD. Nevertheless, the previous work seems to lack attention on *summative* or *post-release assessment* regarding user experience and usability after the product or service has been released on market. When "assessment" is discussed in RD projects of research mainly refers to iterations of ideas and solutions *during* the process of product development. This brings to a question that we will explore by means of case study: if a solution is designed responsibly but brings to services or products that are not completely usable or in line with the expectations of the users in terms of experience, can we say it is a responsible solution?

We utilized a case study on shared mobility to explore this question and to gain insights to review and extend the FRDP. In the case study, we performed a quality assessment of a digital service for shared mobility. With this we aimed to inform the potential full scale-up of

the service to a larger population. FRDP was used retrospectively to check how much the service was designed and delivered in tune with the principles of RD. The collected data were used to inform the potentiality of the full expansion of the service, as well as to gather lessons from the case to be adopted into the FRDP as complementary aspects or elements.

3 Case Study: Stad-Up

Stad-up is the mobility service of the Municipality of Enschede that aims to serve employees of the Municipality to reduce the usage of private cars in favour of electric cars. This service was designed following the concept of Mobility-as-a-Service (MaaS; Li & Voege, 2017) to propose a solution to existing traffic, parking, road and living condition problems of the inner cities. The idea behind MaaS is to realize the shift from car ownership to shared transport and ultimately sustainable development. The Municipality has partnered with multiple suppliers and operators including electric car supplier and local parties such as education and care institutions and the business community (INC, 2019) to initially develop the service only for the employees and then to scale it up to the entire community.

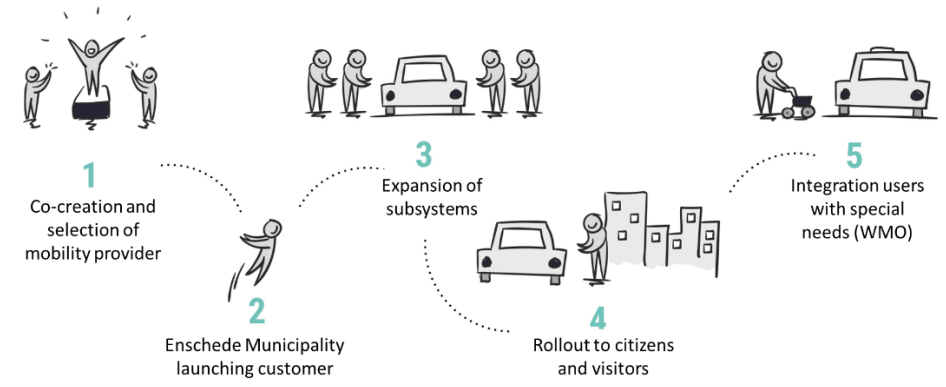
The current Stad-up service offers four sustainable transport modes: (shared) electric car (e-car), (shared) electric bike (e-bike), bus and train (NS). Required technology and infrastructure (e.g., charging points, an app for planning, reservations and payment) have already been developed. There are now 17 e-cars and 20 e-bikes in total located in three underground garages in the city. To access the car, the user makes a reservation and activates it through the app, ConfCar, which has around 180 registered users. Approaching the reserved car, the user's phone connects to the car via Bluetooth and the user can open the car by further operation on the app. Inside the car, there is a charge tag user can use to (re)charge the car from the charging point. If the user has difficulties in the process, they can call the helpdesk supported by Baan Twente. To use the e-bike, the user should first go to the service desk near the bike-parking spot to take the key, and then they can unlock the bike. To use the bus and

the train, the user uses a personal NS business card Stad-up has offered to them. These transport modes together work around contingencies and user needs. If the ride takes less than 10 km, the e-bike is the best option. In bad weather conditions or if the travel distance is above 10 km, one is encouraged to check the possibilities with public transport. If the ride distance is above 10 km, but there are no public transport options, the e-car is recommended. The aforementioned is simply a guide, meaning that the user has free choice of transport.

The ambition of Stad-up is to promote responsible usage of cars and to offer a service to the citizens to reduce the usage of private cars, promote the usage of electric cars and support citizens without cars. In this sense, Stad-up is an RD service that has been rolled out by involving key stakeholders (employees of the Municipality) but also aims to become a service for the entire city as represented in Figure 3. The service's rollout is currently at the end of Stage 2 and in the preparation of Stage 4. However, due to certain circumstances, Stage 3, which is the expansion of the service to companies, health care institutions and other establishments, has been skipped. Instead, user research among the current users (i.e., employees of the Municipality) and potential users (i.e., citizens) is in progress.

Figure 3

Step-Wise Approach for Rollout and Expansion of Stad-up (Adopted From INC, 2019)



3.1 Goals of the Case Study

The present case study aims to answer the research questions: i) first how does Stad-up work for the current users, and what are the limitations and strengths of the service? ii) whether is it feasible to scale up Stad-up to the citizens; and iii) what are the requirements for the stakeholders concerning expanding Stad-up to the entire population.

To achieve these goals, we performed research by interviewing and surveying citizens and current users of the service. This offered us the possibility to test on a concrete case the FRDP by using it as a checklist to identify what important aspects were left out in the design of the service. We undertook the tasks as a group that consisted of an Industrial Design Engineering (IDE) student and a Psychology student. We also collaborated on data analyses, data visualization and all the other outcomes that are shown below. Additionally, professional instructors from IDE and Psychology, along with the strategic company INC, guided and supervised the research process.

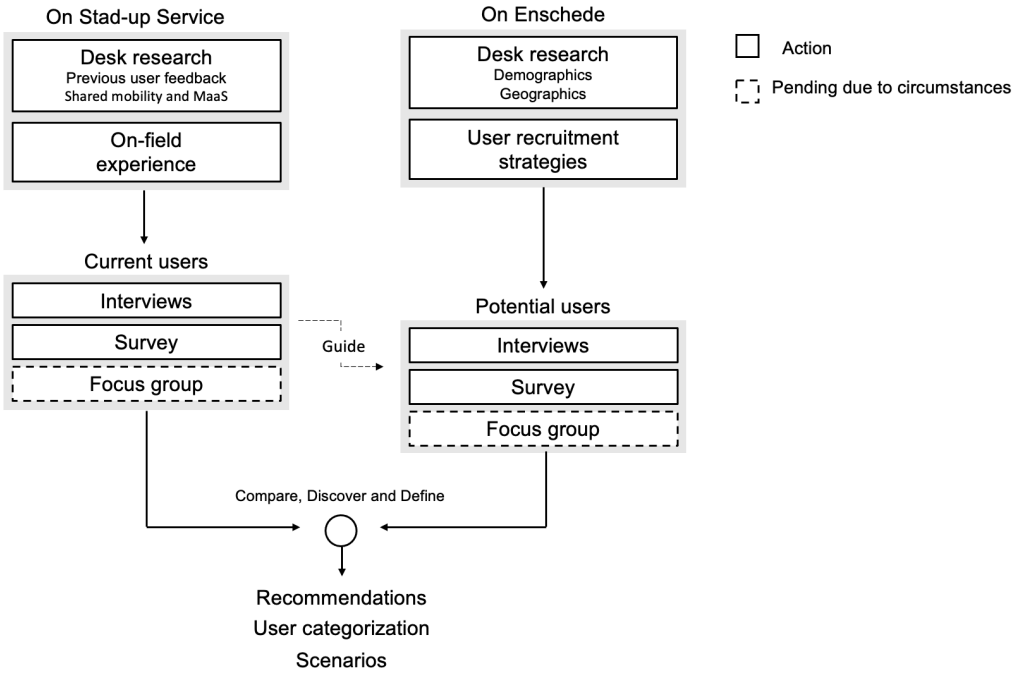
3.2 Methodology

Current users and potential users (citizens) were involved in interviews and in a survey study as represented in Figure 4. The survey study was meant to investigate the current user experience with the Stad-up service and to discover the motivation or resistance factors for citizens to adopt the service. The interviews were meant to obtain a deeper understanding of current users' experience with the service and to observe the citizens' expectations about the service to inform its potential scale up.

The user experience analysis of the service was conducted by an online survey and a semi-structured interview. The study was approved by the Ethics Committee of UT.

Figure 4

Diagram of Procedure of User Research



3.3 Interview and Survey of the Current End-users of Stad-up

3.3.1 Participants

A total of 103 current users (66 male, $M_{age} = 47.5$, $SD = 9.3$) were involved in this phase of the research composed of a survey and an interview:

- Out of 134 employees who voluntarily participated in the survey. We excluded 38 participants who did not fill the survey completely or correctly. The final dataset was composed of 96 participants (60 male; $M_{age} = 46.4$, $SD = 9.0$).
- Seven employees (6 male, $M_{age} = 49.1$, $SD = 8.5$) were involved in the interview for us to further explore the experience with the Stad-Up service.

3.3.2 Procedure and Materials

The survey was prepared in Qualtrics (https://www.qualtrics.com/). The questionnaire was developed in agreement with INC and the Municipality. After the informed consent participants received questions about personal experience with Stad-up and intention of further use of the service (see Figure C1 in Appendix C for the survey flow).

We collected data about individual characteristics, as well as intention to adopt the service for private use using a binary question "Would you use Stad-up for private use? – Yes/No". Moreover, we asked participants to assess their expected level of usability before the use of the service and the present experience after a period of use by employing the short version of the User Experience Questionnaire (UEQ-S; Schrepp, Hinderks, & Thomaschewski, 2017). UEQ-S has six factors: Attractiveness, Perspicuity, Efficiency, Novelty, Dependability and Stimulation. It is composed of nine questions in a form of pair-wise comparison on a scale with 5 points. Table 6 presents the main variables collected by the survey.

Table 6

Key Variables Collected by the Survey

Individual characteristics	Perceived usability	Intention of use
Age Sex Education level Household size Number of cars possessed by the participants Prior experience of e-car	Perceived usability before using Stad-up (Before-use perceived usability) Perceived usability after using Stad-up (After-use perceived usability)	Intention of use after using Stad-up

The one-on-one interviews were performed remotely on the video conferencing platform Microsoft Teams (https://www.microsoft.com/nl-nl/microsoft-teams/group-chat-software). Each interview was video recorded and deleted after transcription was done. Seven interviews were conducted with Dutch-speaking employees of the Municipality. Before each interview, the interviewee was asked to complete a small questionnaire that collected the demographics and basic mobility-related information. The interview guide is presented in Appendix E.

3.3.3 Data Analysis

Survey Data Analysis. We used for the data analysis RStudio (version 1.3.1093) and excel to analyse the quantitative data. Firstly, we performed descriptive analyses to get a general picture of user distribution, characteristics, attitude, experience and expected experience with the service.

Secondly, to inform how to expand Stad-up to the entire population we performed Chi-square tests to investigate if the *Intention of adopting Stad-up (for private use)* was affected by individual characteristics and preferences of the participants such as how many cars in one's household or one's previous experience with e-cars etc.

Then we investigated if the usability perceived before and after the use of the Stad-up service was affected by individual characteristics. Moreover, we performed a stepwise regression analysis on *After-use perceived usability of Stad-up* and *Intention of adopting Stad-up*, respectively, to identify factors that affect the perceived usability and use intention of Stad-up. For a full review of the analysis scheme and how they were to be analysed, see the Survey Configuration and Data Analysis Schemes in Appendix G. The R codes and statistical results are reported in Appendix I.

Interview Data Analysis. the main objective of the interview was to explore the potential factors that could motivate current users to further adopt Stad-up for private use. We categorized interviewee statements about their experience with the service and identified positive and negative user experiences in different stages of the interaction. We then mapped the findings via a journey map and extracted key insights from the insights provided by the end-users for potential improvement of the service.

3.4 Interview and Survey of the Potential End-users of the Service

3.4.1 Participants

A total of 101 citizens as the potential end-users (51 male; M_{age} = 30.5, SD = 7.3) were involved in this phase of the research composed of a survey and an interview:

- Out of 130 citizens voluntarily participated in the survey. We excluded 43 participants who did not fill the survey completely or correctly or those whose age or living area was beyond our focus. The final dataset was composed of 87 participants (43 male; M_{age} = 28.9, SD = 9.4).
- 14 citizens (8 male, M_{age} = 30.2, SD = 9.1) living in the Singel area of Enschede were involved in the interview for us to further explore the feasibility of expanding Stad-up and how to expand it to the general population. Ten interviewees are Dutch and the other four are International.

3.4.2 Procedure and Materials

The survey flow (Figure D1) and the survey questions for potential users are shown in Appendix D. Same as the survey for current users, this survey also received ethics approval and contained participant consent request.

We collected data about individual characteristics including dependency on the car as daily transport using question “How important is your car for your daily travel?” on a 6-point scale (1 = very unimportant, 6 = very important). Moreover, we investigated citizens’ attitude to shared cars (question “How do you think of shared cars?”) and attitude to Stad-up (question “How do you think of Stad-up?”) both with a 5-point scale (1 = very negative, 5 = very positive). Lastly, intention to adopt Stad-up (question “Would you use Stad-up for private use? – Yes/No” was measured. Table 7 presents the main variables collected by the survey.

Table 7

Key Variables Collected by the Survey Among Potential Users

Individual characteristics	Attitude & Evaluation	Intention of use

Age	Attitude to shared cars	Intention to adopt Stad-up
Sex	Attitude to Stad-up	
Education level	Subjective rating of App	
Household size		
Work status		
Number of cars possessed by participant		
Prior experience of e-car		
Prior experience of shared mobility		
Perceived importance of car as daily transport (dependency on car)		

The one-on-one interviews were conducted with basically the same platform, settings, procedures and measures to protect data as those in the interviews with current users, except that one was conducted via phone call upon request. Before each interview, the corresponding interviewee filled out a small questionnaire that collected the demographics and basic mobility-related information. The interview guide is presented in Appendix F.

3.4.3 Data Analysis

Survey Data Analysis. Firstly, we performed descriptive analyses to get an overall picture of user distribution, characteristics, attitude to and intention of adopting Stad-up. Secondly, we performed Chi-square tests to investigate if *Intention of using Stad-up* were affected by individual characteristics like perceived importance of a car as daily transport (dependency on the car), as well as by preferences of the participants such as how many cars possessed or frequency of using public transport etc. Moreover, we used ANOVAs to explore if the *Attitude toward Stad-up* and *Attitude toward shared cars service in general* were affected by the individual characteristics of the participants. Then, we performed regression analyses on *Attitude towards Stad-up* and *Intention of adopting Stad-up*, respectively, by using individual characteristics and *Attitude towards shared cars* as predictors. With these analyses, we aimed to identify influencing factors for attitude and intention of the use of Stad-

up as a service for the entire population. For the complete analysis scheme, see the Survey Configuration and Data Analysis Schemes in Appendix H. The R codes and statistical results are in Appendix J.

Interview Data Analysis. The objective of the interview to the potential users was to identify the individual characteristics of the potential users and the factors that could potentially improve users' adoption of Stad-up. We first organized the interview data in a coding sheet. Next, we grouped similar statements and meanwhile, we decided on the main behavioural variables as a reference for user categorization and pattern detection.

3.5 Results

3.5.1 Survey Results of Research Among Current Users

Descriptive Analysis. The descriptive analyses of the participants' characteristics are reported in Table 8. The perceived usability of Stad-up was overall below the average level of 68% (Sauro, 2011). Perceived usability rating of Stad-up did not significantly change after as compared to before usage of it (58% vs. 64%) suggesting that the service was perceived as not satisfactory in terms of usability before and after the usage. As reported by the end-users, 66% of Stad-up participants of the survey have resorted to the helpdesk for different reasons associated with the usage of the service, with a particular focus on issues associated with the app that supports car and bike reservation and return, that was generally rated negative with an average rating of 55%. The 70% of the respondents indicated they would not adopt Stad-up for private use.

Table 8

Individual Characteristics of Current Users in the Survey

Baseline characteristics	n	%
Age		
Over 65	1	1

46-65	59	61
25-45	36	38
Education		
HBO	49	51
Master	18	19
Bachelor	9	4
Other	20	26
Household size		
>4	13	13
4	20	21
3	15	16
2	35	36
1	13	14
Number of cars possessed by participants		
>2	2	2
2	31	33
1	59	61
0	4	4
Location		
Within Singel area	24	25
Outside Singel area	72	75
Prior experience with an e-car		
With experience	27	28
Without experience	69	72
Prior experience with shared mobility		
With experience	6	6
Without experience	90	94

Note. N = 96.

Chi-square Tests. *Intention of using Stad-up for private use* significantly changes on the basis of the *Number of cars possessed by participants* ($\chi^2(1, N = 90) = 5.42, p = 0.020$), as well as the *Prior experience with an electric car* ($\chi^2(1, N = 90) = 7.72, p = 0.005$).

Regression analysis. The *Subjective rating of the APP* ($b = .42, p < .001$) and the perceived usability of Stad-up measured before its use (*Before-use perceived usability*) ($b = .66, p < .001$) are significant predictors of the perceived usability of Stad-up measured after

its use (*After-use perceived usability*), The overall model fit was $R^2 = .73$, $F(4, 49) = 37.7$. Additionally, *Subjective rating of the APP* also significantly predicts *Intention of using Stad-up*, $R^2 = 0.19$, $F(4, 49) = 4.16$, $b = .33$, $p = .018$.

3.5.2 Interview Results of Research Among Current Users

A total of 77 statements (53 negatives, 24 positives) regarding the service were extracted from the 7 interviews. The most-reported negative aspect of the service is the perceived usability of the service that received 69% of negative statements associated with for instance problems in the inefficient reservation system for the e-car. See Table 9 for an overview of the negative and positive statements of the participants regarding the service.

Specifically, the reservation system for the cars lacks efficiency and adaptivity (15% of negative statements). Users have to plan at least 15 minutes ahead of time, not being able to use the car almost immediately on demand, for instance, within 5 minutes.

> *E1: "I think the thought is fine, but it is difficult that you constantly have to do planning. I cannot schedule an appointment last minute because I am not sure about the availability of the car and the reservation takes at least 15 minutes."*

Besides, the usability of the App is a an obstacle (9% of negative statements), which led to the need of calling the helpdesk (8% of negative statements). Problems include the app being unable to open or close the door (while controlling the doors depends on the app) and failed connections between the app and the car, which are mainly technical errors.

> *E1: "...but that app can also be annoying because it several times must charge before opening that car."*
>
> *E3: "I am familiar with the app because I have really used it a lot but I had to call the helpdesk 50% of the time and the vast majority of the times I called I was indeed not wrong, but there was indeed something malfunctioned... the connection between the app and the car is not always accessible."*

The usability of the App also is reflected in the cumbersome user flow. For example, the user has to sign in to the App again to confirm system messages after the use of the car, which, adding to the technical errors, dramatically compromises the user experience.

Additionally, the many steps to book and start the car is more time-consuming than the previous way of using a petrol car.

> *E5: "I am not saying that it is not a user-friendly app, but the fact is you have to go back, and sign in again and then indicate again yes I have it on the charger, yes I got it, yes I got that, but then it sent you an error message and it turns out that you just have to ignore it..."*
>
> *E2: "I have calculated approximately it costs us about 20% more time through this project."*

Worse still, there either is no car available that meets the travel distance demand of the user, or are cars available but undercharged. This problem, combined with the insufficient reservation system and the problems with the App, may put users under time pressure and at the risk of being late for their events.

> *E2: "Well there are a lot of cars, but sometimes when those cars are somehow undercharged then you get them not assigned and then it can sometimes be that you are sent to the van Heek garage and then you have to walk there again for 10 minutes and then your appointment is gone, so it is also very clumsy..."*
>
> *E4: "You just come under extra time pressure because of this kind of thing... you want to arrive on time and you don't want to be late and reality is just that you often only get in the car at the last minute and then the app does not work, then you have to be stressful."*

Table 9

Statements About Current User Experience Extracted From Interviews

Statements	n	%Statement of valence	%All	Category	%Statement of valence	%All
			Negative statements			
Inefficient reservation system	8	15	10		69	47
Bad usability of the App	5	9	6			
Cumbersome user flow	4	8	5			
The need to call the helpdesk	4	8	5			
Inadequate or unclear information about how to use the service (incl. app, car etc.)	4	8	5			
Connection problem	3	6	4	Usability of the service		
Effortful process of car recharging	2	4	3			
Mismatch between car offered and personal need	2	4	3			
Usability of the car (not easy to remember how to start the car)	2	4	3			
Lack of flexibility of time of using the car	1	2	1			
Uncertainty about which type of cars reserved	1	2	1			
Poor availability of usable cars	5	9	6	Availability of (usable) transport devices	13	10
Poor availability of usable bikes	2	4	3			
Restricted range of the e-car	4	8	5	Range of the e-car	7	5
Poor availability of useful helpdesk	4	8	5	Customer service	7	5
Bad car (interior) maintenance	1	2	1	Car (interior) maintenance	2	1
Too conspicuous the features of the car (the marks)	1	2	1	Anonymity	2	1
			Positive statements			
Good driving experience	4	12	5		68	23
Good availability of useful helpdesk	3	8	4	Usability of the service		
Convenience of the service	2	8	3			

Easier user flow for bike sharing	2	8	3			
Good quality of bikes	2	4	3			
Clear information about how to use the service	1	4	1			
Easy reservation via the App	1	4	1			
Good bike-riding experience	1	4	1			
Planning allowed within the system	1	16	1			
Environmentally friendliness	4	4	5	Environmental benefits	16	5
Cost saving possibility	1	4	1		8	2
No responsibility of car maintenance	1	4	1	Economic benefits		
Good availability of (usable) cars	1	4	1	Availability of (usable) transport devices	4	1

Note. $N_{all\_statements}$ = 77 ($N_{positive\ statements}$ = 53; $N_{negative\ statements}$ = 24).

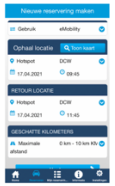
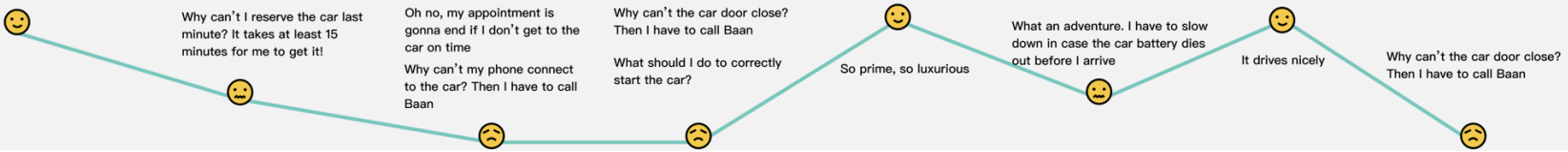
* statement of valence means either negative statement or positive statement; the percentage of the statements of valence means the percentage of the particular statement of a specific valence (on leftmost column) among all statements of that valence.

To visualize the current user experience with the Stad-up in using e-cars a journey map was developed base the insights from the interview (Figure 5). We focused on e-car as the service received the most negative feedback regarding the use of such vehicles, (see: Table 6).

Figure 5

Customer Journey Map for User Experience With the Electric Car Within Stad-up

CUSTOMER JOURNEY MAP: MAPPING THE EXPERIENCE OF CURRENT USERS OF STAD-UP

	Planning	Reservation	Pick-up	Preparation	On the road	Re-charge halfway	On the road	Return
Actions	Use Google Maps to plan my trip Mainly look at the time and km	Open ConfCar app Choose pick-up location Select an available car	Receive a license plate 15 min before my ride Go to the car Take further actions on the app to unlock the car	Take the charge card from the car Hold the charge card against the charging station to unlock the cuttings. (Call the helpdesk for help) Disconnect the car and the charge station Get in the car to prepare to drive Look at the manual to see how to operate	Drive...	Use Plugsurfing or Google Maps to search a charging point Open ConfCar app and close the car door; leave the car Connect the car and the charge point	Drive...	Deliver the car to the same place where it was collected Take the charge card, connect the car to the charge station Check around in the car, take all belongs out and close the door Open the app to terminate the appointment Call helpdesk to close the door
Pictures			 					
Touch points	Cell phone (Google Maps app)	Cell phone (ConfCar app; Email)	Cell phone (ConfCar app; bluetooth) Path guides and signs in the garage The car	Charge card Charge station Cable The car	The car (interior)	Charging station Cell phone (ConfCar app, Plugsurfing/Google Maps)	The car (interior)	Charge card Charge station Cable The car Cell phone (ConfCar app)
Thoughts / Emotions		Why can't I reserve the car last minute? It takes at least 15 minutes for me to get it!	Oh no, my appointment is gonna end if I don't get to the car on time Why can't my phone connect to the car? Then I have to call Baan	Why can't the car door close? Then I have to call Baan What should I do to correctly start the car?	So prime, so luxurious	What an adventure. I have to slow down in case the car battery dies out before I arrive	It drives nicely	Why can't the car door close? Then I have to call Baan
Pain points		No available car. Car given doesn't match the user's personal or travel need	Too cumbersome system, not easy to use Have to travel extra distance to get to the pick-up point (another garage) Uncertain about the car to get Can't connect to the car	The car doesn't open automatically (problem with the App) Can't close the door (problem with the App) Lots of information needs to be remembered to make things right	Sometimes someone leaves the car dirty	The range of the car is too limited Charging station can be far		Can't close the door (problem with the App) Cumbersome process to confirm things on the App after use

3.5.3 Survey Results of Research Among Potential Users

Descriptive Analysis. Table 7 shows the individuals characteristics of the participants. 74% of the respondents declared that their car is at least somewhat important to their daily mobility (18% “somewhat important”, 25% “important”, 31% “very important”). The overall attitude to shared cars is negative, with an average rating of 64% (3.2/5 points). 55% of the respondents indicated they would not use Stad-up.

Table 7

Individual Characteristics of Potential Users in the Survey

Baseline characteristics	n	%
Age		
Over 65	5	6
46-65	23	26
26-45	44	51
18-25	15	17
Gender		
Female	44	51
Male	43	49
Education		
HBO	33	38
Master	20	23
Bachelor	10	12
Other	24	27
Work status		
Full-time employed	44	51
Part-time employed	14	16
Student	8	9
Unemployed, looking for job	7	8
Retired	5	6
Other	9	10
Household size		
>4	8	9
4	13	15
3	10	12

2	41	47
1	15	17
Number of cars possessed by participants		
>2	7	8
2	13	15
1	48	55
0	19	22
Prior experience with e-car		
With experience	25	29
Without experience	62	71
Use frequency of public transport		
Every day (very often)	0	0
Often (less than 2 or 3 times a week)	7	8
Sometimes (about 2-3 times a month)	18	21
Rarely (about once a month)	23	26
Never	39	45

Note. N = 87.

Chi-square Tests. Results indicate that *Intention of using Stad-up* significantly changes on the basis of *Number of cars possessed by participants* (χ^2 (1, N = 71) = 4.83, p = 0.028) as well as *Use frequency of public transport* (χ^2(1, N = 71) = 7.52, p = 0.006).

ANOVAs. *Attitude towards shared cars* significantly varies across levels of *Number of cars possessed* (F(1, 83) = 12.51, p < .001) and *Use frequency of public transport* (F(1, 83) = 13.12, p < .001).

Regressions. *Attitude towards shared cars* is significantly predicted only by *Dependency on car as daily transport*, R^2 = .19, F(6, 60) = 3.58, b = -.20, p = .012. *Intention to use shared cars* predicts *Intention of using Stad-up*, R^2 = .23, F(6, 53) = 4.01, b = .47, p = .004.

3.5.4 Interview Results of Research Among Potential Users

The end users were mapped into five groups (Table 8), based on the following demographic and behavioural characteristics: having children or not (and age of the children),

the number of cars owned, use frequency of cars, most-used transport mode, awareness of sustainability, the influence of sustainability awareness on purchase decision-making, attitude towards public transport, attitude towards shared mobility, and cost-sensitivity.

Table 8

User Profiles

	Profile 1 Active cyclist without a car	**Profile 2 Vehicle-independent car-owner**	**Profile 3 Cost-sensitive student**	**Profile 4 Inveterate car-owner**	**Profile 5 Conservative car-owner**
Main characteris-tics	- Mostly not possessing a car - Highly aware of sustainability - Do not mind using their bike for longer distances	- Open to the idea of shared mobility - In the possession of a car, but not for daily transport - No (young) children	- Students - Highly cost-sensitive - Mostly travel by public transport or bike	- Car is most used transport device and part of their daily transport routine - Using the car for shorter distances - Comfort-oriented	- Not a fan of shared mobility - Highly value private possessions - Do not want to share with strangers - Especially unwilling to use shared mobility when having (young) children around
Potential relation to Shared Mobility and Stad-up	*Positive to Stad-up and intend to use if the facilities are ready and reliable*. Are positive about the idea of Shared Mobility and thus Stad-up; but this group do not directly need a car so the service must be satisfying when they are in incidental need of a car, otherwise, they'll use another option.	*Positive to Stad-up but do not need it.* Are not influenced by children in their daily transport. Are positive about the idea of shared mobility and open to using it, but they do not need it because they already have a car. For them the car is more than sufficient. So for them to use it, first their life situation would have to change.	*Positive to Stad-up but they have other better green mobility options.* Have student transport cards and special offer, so public transport and bikes are the best options for them. They think the idea is fine are open to the idea of shared mobility but since the current option is already satisfying and for the reason of costs, they are not likely the main user group of Stad-up.	*Neutral to Stad-up but will probably rarely use it.* Highly value their own car for their daily transport because of availability and comfort/ convenience, and therefore have become dependent on their car for daily use, even if they have sustainability awareness. They would not get rid of their car. It is more likely for them to buy their own e-car.	*Negative to Stad-up.* Comparable with They do not like sharing things with strangers and so do not like the idea of shared mobility services. They are more likely to buy their own e-car if they want to "drive green".

Profile 1 users express positive intention of using Stad-up out of concern for the environment and their occasional need for a car, about twice a week, they are most likely to be the first user group of Stad-up. Profile 2 users, although positive to the service, seldom use

even their own car. Their car suffices more than they need. Profile 3 users are the student group, who are expected to be the “low-value” user group since mostly of them are not yet financially self-sustained and they have other much cheaper transport options. Profile 4 users think that the idea of Stad-up is not bad, but they are quite dependent on their own car as a daily commute tool. They prefer immediate convenience the most. Therefore, they are not expected to use the service as much as Profile 1. Profile 5 users are negative to the concept of shared mobility in general, so they are not likely the main target group of the service. Given the relatively higher motivation and need of Profile 1 users to use shared mobility, the service provider should prioritize this user group in the early roll-out. Possible use scenarios for Profile 1 include transporting goods bought from stores or groceries, travelling in bad weather conditions, going on trips during weekends.

Besides the above individual and behaviour differences that accounted for the variation among users investigated, there are several shared-mobility-related factors that may influence users’ intention of adopting Stad-up. We identified these factors from a prior study (Machado, de Salles Hue, Berssaneti, & Quintanilha, 2018):

- **Availability guarantee** of partial transport: the guarantee that you can always use partial transport when you need it.
- **Parking options** upon return: the obligation to return the car at the same place or not.
- **Insurance and Deductible**: which are specified by the terms of use in case of possible damage and/or traffic accidents.
- **Kilometre costs** of shared transport: the price of the distance travelled with the partial transport.
- **Subscription costs** of shared transport: the price of possible subscription for using the partial transport service.

- **Proximity** of shared transport: which is determined by the walking or cycling distance that one has to cover before they can physically access the shared transport.
- **Offer** of shared transport: which is defined by the range or variety of different vehicles and means of transport within the service.

We used the above elements to review and aggregate the statements of the interview participants. We found that the availability guarantee is the most important aspect for them. The transport device has always to be available or an option to reserve beforehand should be implemented.

C8: "... why would you use it if it's not there when you want to use it?"

Ensuring availability is required for developing user trust in the service. A common reason behind the importance of availability indicated by the interviews is that in case of emergencies it is critical that a car is at hand, which motivates users of Profile 3 and 4 to keep their car even when it is not used often.

C4: "There is one car at the door...for emergency use...when a family member gets injured then we can use it."

Another strong influencing factor is proximity of the service, that is, how much distance one has to cover before they access the transport device. The interviewees mention that if this takes much effort, they would not use the service. A walking distance of 5 to 10 minutes is acceptable, but an amount more than that will reduce user motivation. The occasional needs to carry groceries or big items may make the need for availability more significant, as indicated by C10 who said she sometimes drives to the supermarket or IKEA to pick up something and she does not want to walk much carrying the goods back home even though she could drop the goods first and then returns the car. Therefore, close proximity means fewer hassles to users and better time-efficiency, and thus potentially higher use intention.

Furthermore, costs should be reasonable in order for users to consider it in the first place. otherwise, they would not use it. It seems that a fair price is virtually the prerequisite for users to adopt the service.

> *C1: "...will use it when its expense is at least as cheap as public transport... I'll always just go for a cheapest option."*
>
> *C8: "It must offer advantages, so it must be lower than owning a car yourself; costs are important and especially in relation to use frequency and how my own car costs in return."*

The other possible factors do not appear to be as critical as the above three. The parking option, that one has to return the car to the same pick-up spot as indicated by C7 "comes hand in hand with accessibility". As suggested by previous studies (e.g., Anagnostopoulou, Bothos, Magoutas, Schrammel, & Mentzas, 2018), instant availability of parking might be a "deal-breaker" especially in crowded big cities. It does not seem to be a problem in Enschede for its relatively small size. But still, good parking accessibility and availability should be realized to make efficient the user journey. The offer aspect is mostly not important, because what matters is the possibility provided by a car to transport one from A to B. It is acknowledged by interviewees that more types of vehicles would be perfect since users can tailor their choice of vehicles to their specific needs (e.g., the number of passengers). 12 out of the 14 interviewees mentioned that damage agreements should be communicated unambiguously in that distributed responsibility between the user and the service provider is clear.

Regarding options of Stad-up instalment in Enschede, although the interviewees are mostly positive about the idea of shared mobility, they doubt that Stad-up will work in the city. Firstly, Enschede is a small city and the 10 out of 14 interviewees say almost everywhere within the city can be accessed by bike. Secondly, they are satisfied with biking and the train system, as indicated by the 11 interviewees. mainly because of the size of the city. The e-car

is overall seen as the most appealing to the interviewees, as a possibility for incidental use granted that the service meets all the conditions as stated above.

3.6 Discussions

3.6.1 Discussion of the User Research Results

The results suggest that the main issue experienced by the current users of Stad-up are due to usability problems experienced during the journey including but not only limited to the App of the service. The poor usability of the service which is mostly visible in its inefficient user flow of car reservation and the unreliable App. These aspects decisively affect the user willingness to continue using the service. To regain the trust of the current users, the car reservation should be made smarter and adaptive to user needs, allowing users to get a car within an acceptably flexible time frame. Moreover, a redesign of the App in terms of both user interaction and technical aspects is imperative.

Concerning the potential expansion of the service to the entire population, our investigation of citizens' perceptions and expectations reveals that the potential users have an overall positive attitude toward the idea of Stad-up mainly because of its sustainability. In particular, potential end-users with moderate to strong environmental awareness who are not owners of car could be considered a target group for the Stad-up in its early roll-out phase. Nevertheless, apart from the redesign to ensure usability participants regarding the potential scaling up of the service highlighted that it is important to guarantee: i) facilities that are available around the city, instead of localised in one or two points in the city centre, as potential users prioritise the availability of cars and proximity as main factors to use the service, and ii) costs of the services that could be competitive with the costs of using other traditional transport.

3.6.2 Reflection on the Stad-up Research and Design Processes

We reviewed the RD approach that has been applied during the development Stad-up by means of the FRDP that we proposed in the section Systematic Literature Review. Details of our review are reported in Table 9.

Table 9

Analysis of Stad-Up Processes Based on Framework of Responsible Design Practice (FRDP)

Principles of RD	Service development phases		
	H (Hear) phase	C (Create) phase	D (Deliver) phase
Reflexivity & context	Before the project started, the Municipality and related parties created the blueprint of the project based on the local civic and traffic situations.	Before the rollout to all employees of the Municipality, INC held offline workshops to involve the first users to receive feedback, which is a suitable way to learn about the user experience. Perhaps to gain understanding of the users and how they interacted with the service could also take place in context of the service use. This is a more direct way to both have empathy for users and be informed of the problems in the service, which was possible under the circumstances then. However, the developers of the service were not sufficiently involved to get first-hand knowledge about the problems in the service that was being developed. Perhaps they could have better talked directly to the end-users in an earlier phase of the service development.	Within a long period of time after the release of the service, there was no further follow-up research on how users interacted with the facilities and their overall experience. After the rollout to all employees, exploration was conducted in the local communities. Needs were explored and understood in the local context, in consideration of local cultures, life styles, values, and other indigenous characteristics like traffic planning and urban design. However, no investigation was done in the context of service use. All interviews and surveys were conducted online. Thus, a good contextual understanding was lacking.
Value sensitivity	The project itself is of responsible intent: the service is to serve “goodness” — goodness to people (i.e., improvement of quality of life, health, equality), goodness for sustainability of the environment, and goodness for positive social change (e.g., raised public awareness of sustainability).	Before the rollout to all employees, INC held offline workshops to involve the first users to give feedback. But as far as has been known, there was insufficient understanding of the employees’ values, individual lifestyle or other relevant aspects. At least from retrospection, we know that after the rollout to all employees	While the service was in place the initiators sought ways to take more advantage of the available mobility means even during Corona while cars were unutilized more than originally expected. This reflects the responsible thinking and intention of the initiators.

		the service was not user-friendly enough, not to mention being human-centred.	During the user research among current and potential users, participants' data were well protected, research ethical principles such as anonymity, obtaining informed consent and giving participants the right to withdraw and choose research approach as they would, were fully respected. Moreover, UT surveyed about the potential users' personal values, their lifestyle and their motivations regarding adopting shared mobility.
Awareness of societal consequences	Before the project started, the commissioner (i.e., the Municipality) shared their vision about sustainable city innovation with the research team. The very starting point of the Stad-up project is to reduce the human burden on the environment and improve the quality of city life by means of mobility innovation. However, no end-users were involved. A year after the roll-out to all employees, the research team was involved. Beside learning the project background, they investigated the geographics and demographics of the City of Enschede as an attempt to familiarize and understand the local situation/context.	The Municipality and INC did investigations on and predicted how Stad-up would provide environmental (lower CO2 and more efficient use of space etc.) and social (safer roads etc.) benefits based on their knowledge about shared mobility and MaaS.	No systematic examination or assessment on the recommendations in terms of societal consequences was conducted when the service was ready to be release. Likewise, no investigation on the societal consequences was conducted after the service was put in use by the current users (employees).
Formative assessment	Before the full roll-out, INC collected user feedback from two workshops (feedback sessions) to identify teething (technical) usability problems.	User experience and usability of the system got assessed via user feedback session before the full rollout of the service. Usability problems identified were partly addressed to improve the service before its rollout to all employees.	After the rollout to all employees, no user feedback was collected and neither was investigation on how the users experience the service. Only a year after the full rollout did post-release

			assessments on the current user experience were followed up. The template for organizing qualitative data about user experience used by INC in the previous user feedback sessions before the full rollout was modified and adopted by UT in the post-release user research and assessments, in combination with other methods such as interview and survey, as well as tools such as pictures and graphical demonstrations.
Active participation	Before the project started, stakeholder meetings involving the Municipality, INC and other related parties were held to communicate and co-determine the goal and vision of the project. No end-users were involved to co-decide the vision of the service. After the roll-out to all employees, the research team (UT) was involved with a goal to investigate the user experience with the current Stad-up service and to explore how to expand the service to potential users (citizens). The team kept continuous conversation with the commissioner and INC to learn about the background and vision of the project, understand the problem that design aimed to address. The results to be achieved in the user research phase were also determined in a democratic manner. Research results in-progress were communicated by UT to other stakeholders via online meeting.	Before the full roll-out, two user feedback sessions were conducted for the Municipality and INC to review the usability problems and solve part of them. And then the service was put in use by all employees (current users).	The research team (UT) conducted user research. Current users and potential users were invited to share their experience, expectations and opinions. UT then gained insights on the re-design of the service based on their understanding of the user needs and motivation factors extracted from quantitative and qualitative user research data.

	No end-users were involved to tell their experience and give feedback until about a year after the full rollout of the service, although during this one-year period of some users reported problems in use to Baan Twente, the transport facility provider/supplier.		
Multi-disciplinary approach	Before the project started, the Municipality, educational institutions, and businesses discussed the possibility of innovative mobility to be adopted in the city.	The Municipality commissioned the main construction of the service to Baan Twente, who provided and installed the facilities. Along with Baan, INC provided assistance in strategic aspects.	The research team (UT) collaboration was between disciplines (i.e., Industrial Design, Psychology, and Human Factors). Inter-team activities such as desk research and meetings were performed to achieve a consensus of project goals, research questions and deliverables to be achieved. They collaborated in exploring user needs, expectations, behaviour and pain points in the current user experience. The research team shared with the Municipality, INC and Baan their findings and insights based on the user research data.

Stad-up is intended as an accelerator and guide for the transition from “old” mobility to new alternatives, to innovate the city and better the quality of life of the population under sustainable social development. This goodwill is the base of the awareness of the positive societal impact of the mobility solution (MaaS) that the stakeholders (i.e., governments, institutions and the business market) share. The idea or concept of sustainable mobility, as well as the impact on society and the environment, were tested and examined in the early phases of the service development cycle. However, the analysis of the potential societal consequences did not continue into the later “Deliver” phase and post-release phase. In other words, the social impact of the project was not further reviewed after it was implemented among end-users.

The innovative mobility solution was the result of collaboration and co-creation through partnerships among the government, (knowledge, healthcare etc.) institutions and the business market. It also acknowledges that in the “Create” phase, user feedback was collected and used to guide the first iteration of the service before it was put into usage by all employees. It was only during the present research that users were engaged with other stakeholders to actually understand the value provided by the service, suggesting an inadequate involvement of end-users in the earlier “Hear” and “Deliver” phase. The involvement of potential users (citizens of Enschede) in the early stage could have helped in understanding the potential issues of scaling up the service to a wider population and better informed the design which was mainly designed on the basis of the needs of the employees of the Municipality. Moreover, the current users were not monitored after the release to understand systematically the issues in the design. In this sense, while Stad-up used a

responsible approach, involving stakeholders and end-users, and the intent was only partially responsible as the goal was to produce something for the entire population in the long run, but the solution design is fitting, only partially, the needs of the employees of the municipality of Enschede.

Certainly, in Stad-up assessments of the service took place in the “Create” phase. User feedback sessions were held and then the service was improved by having some usability problems tackled. However, after its rollout to all employees of the Municipality, the service was only minimally supervised and follow-up assessments to inform potential adjustments of the service were not conducted. This was the major issue of the RD approach of Stad-up which could be also considered a generalisable issue of RD practice. It appears that RD practitioners are mainly focused on the design aspects, and the responsibility of what happens to the product after the release of it is unclear. A lesson learned by the case study is that that a responsible design can not stop at the release of the product, and it is necessary to include in RD framework phase of follow up after the release, to actually monitor the user experience and to understand how to adjust the product to bring value to people and to the society. From a business perspective it is important that there is a clear ‘product owner’ that takes full responsibility.

3.6.3 Modifying Framework of Responsible Design Practice

The lack of post-release assessments and partial fulfilment of the original intent of the project are two major issues of Stad-Up. While the latter could be categorised as a mistake associated with the contextual needs and contingencies of the Stad-Up service, the lack of “responsible” assessments seem to be a systematic issue in the field of RD.

Based on what we learned from the case, we revised the FRDP as in Table 10. The revised framework includes new elements: 1) extensive cross-user-group investigation for the implementing "Reflexivity and context" principle; 2) replacement of the "Formative assessments" principle with "Responsible assessment strategy" with an additional emphasis on post-release assessments and not only on formative assessment or co-design phases.

Table 10

Revised Framework of Responsible Design Practices (Revised FRDP)

Principle	Explanation
Reflexivity & context	Be reflexive on ways of working and methods used, in relation to the users' context, and especially the political, moral, and ethical aspects (Steen, 2011). Be aware of the broader systemic context of the 'problem' that is to be addressed (Grimpe et al., 2014). a) Localize the situation: situate the problem, the user and artifact in the local context (Bissett-Johnson & Radcliffe, 2019). Consider the "systemic context" of the problem to be addressed (e.g., Grimpe et al., 2014). **b) Extensive cross-user-group investigation: designers should actually fulfil their intent, for instance, introducing the service to the entire population even if they are designing a service that will be used initially by only one group. Doing so requires designers to consider the broad context where the wider range of groups within the entire population are living, rather than simply that of the first group, otherwise it will be hard to understand all the potential issues for future expansion of the service.**
Value-sensitivity	Respect human values and critically evaluate the investigation process and design outcome against the values. a) Have the right intention: have ethical awareness and sense of responsibility of contributing to sustainability (Haug, 2017). Critically explore societal values, including justice, health, inclusiveness, equality, sharing and civil liberties; reflect on those values throughout the entire design project (Ashour, 2020). b) Have empathy: designers should have the motivation and perform activities to empathize with people and identify their unmet needs. A way for this is getting

	insights into people's everyday experiences and trying to experience their life in context (Cipolla & Bartholo, 2014).
Awareness of societal consequences	Be capable to foresee the impacts of the design concerning the social, humanity, and the environment. a) Anticipate impacts of design: anticipate the impacts of the design outcome on society concerning what societal changes, both positive and negative, may occur; and what effects will the design have on the environment (e.g., Ashour, 2020; Grimpe et al., 2014). b) Ponder the pertinence of design: designers should think about if what they are designing is worth it, in relation to issues like security, privacy, safety, and ownership (Hernandez & Goñi, 2020).
Responsible assessment strategy	Within a project of product development, conduct research, generating solutions and assessing solutions in an iterative and formative manner (IDEO, 2015; Steen, 2011). **On top of that, *post-development or post-release summative assessments* should follow up. Strategies to monitor the user experience should always be implemented to actually ensure that a product or a service that is designed responsibly is also delivered responsibly.**
Active participation	At the core of the Participatory design approach, participation of stakeholders is valuable as a channel for bringing ideals of social responsibility into design (Grimpe et al., 2014). a) Distributed agencies: involve many different stakeholders who come together to negotiate actions, benefits, burdens and properties (Hernandez & Goñi, 2020). Additionally, the end users should be deemed as active agents who can determine how the design will impact others in the world by their decisions. (Hernandez & Goñi, 2020). b) Participatory approach throughout: have all stakeholders (people of various groups from the local community) directly and actively involved in each stage — from the early problem framing stage to the design development process (Grimpe, Hartswood, & Jirotka, 2014). Define and redefine the brief together with users and stakeholders (Cipolla & Bartholo, 2014). Have the the "everyday people" from the local community Co-design in the creation phase, jointly exploring and creating things with the design team (Sanders & Stappers, 2008; Steen, 2011). **c) Good experience in the participation: the design team should always ensure a good "participant experience" for all stakeholders involved. Notably, the design team should design materials to be used in various research or design activities responsibly, establishing satisfactory readability and comprehensibility among other aspects that may attribute to overall "participant experience".**

Multidisciplinary collaboration	*Explanation*: Build a team of members from different disciplines, organize multidisciplinary teamwork and research agenda (Eggink, Ozkaramanli, & Liberati, 2020; IDEO, 2015; McMahon & Bhamra, 2017; Steen, 2011).

4 Responsible Design in Education: the Cases of the University of Twente

In this section, we explored how RD is incorporated in the programmes of the University of Twente to look for potential space for improvement from the educational point of view. We aim to answer the questions: i) what methods and tools of RD are taught in the bachelor programmes of UT? and ii) how to enhance the RD education provided by the IDE and Psychology programmes? We chose the bachelor programs for two reasons. Firstly, bachelor study lays the foundation of RD learning at a higher level and so it justifies the idea of inspecting the pedagogy from the bottom up. Secondly, from a practical point of view, it is easier to find information about the bachelor programs than master and PhD programs.

To achieve these goals, we reviewed the UT programmes to map which elements of the revised-FRDP are taught and gaps regarding elements associated with RD practice.

4.1 Methodology

We first reviewed the 2020-2021 curricula of the bachelor program of IDE and the one of Psychology searching for the six key elements of the FRDP, namely: Reflexivity and context, Value-sensitivity, Awareness of societal consequences, Responsible assessment strategy, Active participation, and Multidisciplinary collaboration. The review was carried out in 2021 by manually scanning the OSIRIS platform which contains information of the courses, including learning goals, and the information retrievable on the website of the University of

Twente. We mainly looked in elements such as “module description”, “course description”, “aim”, and “content”.

We limited the research to two bachelor programmes: Industrial Design Engineering (IDE) and Psychology. These two programmes are representative of the university ecosystem as bachelor students are taught to do research and design/create solutions with new technologies around humans, in line with the educational pursuit of the University of Twente (UT): high tech with human touch. Such a human-centred approach is much aligned with the purpose of RD (de Vere, Bissett-Johnson, & Thong, 2009).

4.2 Results

The results suggest that at least ten courses (5 from IDE and 5 from Psychology) are dealing with contents associated with responsible design practice and methods. Table 11 presents an overview of the courses in IDE and Psychology bachelor programs that shows how the course content and activities relate to RD. As reported in the table, in the IDE program, 100% of the courses are dealing with the aspect concerning Reflexivity & context and Responsible assessment strategy, 80% Value-sensitivity, 60% Awareness of societal consequences and Active participation, and 40% Multidisciplinary collaboration. In the Psychology program, 100% of the courses are dealing with the aspect concerning Reflexivity & context, 80% Value-sensitivity, 80% Awareness of societal consequences, 80% Responsible assessment strategy, 20% Active participation and 20% Multidisciplinary collaboration.

Table 11

Courses Offered at UT That (May) Have Close Relations to Responsible Design

Course /Module	Framework of Responsible Design Practice					
	Reflexivity & context	Value sensitivity	Awareness of societal consequences	Active Participation	Responsible assessment strategy	Multidisciplinary collaboration
			IDE bachelor program			
Y1-M4 **SMART PRODUCTS**	YES Explanation: introduce and require target group analysis in course projects	NONE	NONE	NONE	YES (formative) Explanation: teach generating product ideas through global design, building testing models/prototyping and conducting user testing	NONE
Y2-M5 **HUMAN-PRODUCT RELATIONS**	YES Explanation: guide students to do target group analysis and analyse the situation of the location which they are to design street furniture for (course project)	YES Explanation: teach investigating the relationship between people and products on the individual, social and societal level through the lenses of philosophy	NONE	YES Explanation: students are required to do qualitative and explorative research on users to specify requirements for design and generate design concepts	YES Explanation: require students to perform evaluations on the design against ergonomics standards and industry guidelines about energy and heat transfer and production	NONE
Y2-M6 **CONSUMER PRODUCTS**	YES Explanation: students communicate with the	YES Explanation: students communicate with the	YES Explanation: introduce sustainability and	YES Explanation: offer a development project	YES (formative) Explanation: ideas are communicated through	YES Explanation: students from various disciplines

	clients and obtain understanding of the clients' business and development situation and status	clients and obtain understanding of the clients' needs and values; furthermore, they perform product-market relations analysis	Environmentally Responsible Design in product development; the course project is on designing supply chains that are environmentally friendly and economically efficient	with a factual problem formulation in cooperation with a company or organization (clients); the clients are involved to co-decide plans and solutions with student teams	graphic design and technical product modelling; ideas and models are iterated based on assessments against rules for sustainable product development	work together as a group
Y2-M7 **DESIGNING FOR SPECIFIC USERS**	YES Explanation: teach how to explore user experience in context and empathize with users	YES Explanation: teach how to explore user needs using interviews, field observation etc. and empathize with users through co-design, theatre enactment and other techniques	YES Explanation: the course centres on HCD; the course project is on designing a product for a specific target group, e.g., people with physically strenuous jobs, children, the elderly, or people with a disability	YES Explanation: implement participatory design/co-design by directly involving end-users in user research phase	YES (formative) Explanation: guide on using lo-fi experience prototyping, storyboards and scenarios to communicate concepts; instruct how to evaluate experientiable prototypes	NONE
Y3-M11 **SYSTEMS IN CONTEXT**	YES Explanation: to design a complex system in a realistic situation for meaningful experiences, students are guided to consider the real-world	YES Explanation: introduce concepts of Value sensitive design, Scenario-based design and Meditation Theory; prompt students to contemplate the	YES Explanation: teach Philosophy and Sociology of Technology, Design and Meaning and Design of Mechatronics and Systems (but	NONE	YES (formative) Explanation: evaluate the design against Systems engineering and mechatronic design standards	YES Explanations: students work in relatively large multidisciplinary teams

	context where people interact with the system	"meaningfulness" of design to people's life	Mechatronics and Systems is major content)			
			Psychology bachelor program			
Y1-M1 **PSYCHOLOGY AND INTERVEN-TION DESIGN**	YES Explanation: introduce and guide students to using Systematic intervention design and applying ASCE model (analysis, synthesis, construction, evaluation, engagement and accountability) in the intervention development	YES Explanation: in the "analysis" phase of the ASCE model, students analyse the target group and their needs, values and cognitive characteristics	NONE	NONE	YES (formative) Explanation: the ASCE model taught includes activities of "construction" and "evaluation" (of the designed intervention)	NONE
Y1-M3 **COGNITION AND DEVELOP-MENT**	YES Explanation: introduce the concept of RD intended as a way of Systems thinking that considers the consequences of a design on people and their living context, as well as the environment	NONE	YES Explanation: introduce the concept of RD intended as a way of Systems thinking that considers the consequences of a design on people and their social and societal context, as well as the environment	NONE	YES (formative) Explanation: teach some UCD skills such as lo-fi prototyping skills and assessments	NONE

Y2-M5 **ELECTIVE: Health Psychology & Applied Technology**	YES Explanation: students first analyse and understand the context where users live, which is part of the attempt to apply health psychology theories, persuasive technology models (e.g., CeHRes roadmap and persuasive system design models) and approaches to a practical problems regarding self-management in chronic diseases	YES Explanation: based on communication with end-users and knowledge of psychology theories, students get to understand individual values and empathize with users (patients) and conclude their learning with personas	YES Explanation: the course project is on designing a mini eHealth intervention for chronic diseases which is intended to bring benefits on the individual and societal level	YES Explanation: adopt participatory design: working with patients as partners	YES (formative) Explanation: teach and guide the use of lo-fi prototyping and usability testing for both users and experts	NONE
Y2-M5_C **ELECTIVE: Psychology of safety**	YES Explanation: give lectures that are built on the department's research that is conducted via international-national collaboration which can help students gain a situational understanding of the realistic cases	YES Explanation: teach how to diagnose and analyse social safety issues using psychological theories; identity individual and social values regarding safety issues	YES Explanation: guide assessing social impacts of new technologies, risks and conflicts they may incur	NONE	NONE	NONE

Y2-M6_B **ELECTIVE: Human factors & Engineering Psychology**	YES Explanation: introduce the concept of RD and oppose to irresponsible design due to application of Dark patterns or lack in user research and systems thinking	YES Explanation: introduce the concept of RD and oppose to irresponsible design due to application that lacks user research and thus understanding of users' needs and values	YES Explanation: introduce the concept of Responsible Design and oppose to irresponsible design due to application of Dark patterns or lack in systems thinking (e.g., considering impacts of design on the society)	NONE	YES Explanation: teach how to build interactive prototypes and assess them against human factors and engineering guidelines	YES Explanation: the course includes multidisciplinary group projects involving students in the filed of psychology and creative technology.

Note. Y1 means Year1, and M1 means Module1. For methods for each element of RD , turn to Table 6.

4.3 Discussion

By reviewing the IDE and Psychology curricula we have identified which elements of the FRDP that the courses have or have not covered. On the basis of the review, we will discuss how the programs can further incorporate RD in pedagogy to strengthen the cultivation of students' RD knowledge and capabilities.

4.3.1 Industrial Design Engineering Programme

Each element of FRDP is covered in different degree by various courses. Only one project touches upon all the elements of RD (M2-Y6 CONSUMER PRODUCTS). Educational focus in the first year of IDE education is placed on product engineering and ergonomics. This is justifiable since it orients towards industrial design and engineering. However, it seems that RD as design thinking is just partially introduced in the first year, with only the Reflexivity & context and Responsible assessment strategy included in the course SMART PRODUCTS. Considering the importance of cultivating a responsible mindset (de Vere, Bissett-Johnson, & Thong, 2009) of students, the RD principles that concerns the intent of solution (i.e., Reflexivity & context, Value-sensitivity and Awareness of societal consequences) should be fully introduced in the first year so that students can adapt to such design thinking early on in their IDE study period.

The aspect of Awareness of societal consequences, although integrated into multiple courses, sees room for improvement. Lecturers can invite students to actually anticipate the societal impacts that their design or deliverables would have using a structured tool such as Product Impact Tool (Eggink, 2020), and Reflective Inquiry via GIGA Mapping (Lutnćs, 2017). Moreover, students should also be encouraged to iteratively conduct such anticipative analysis across different stages of product development in order to make pertinent design decisions.

Furthermore, despite the well-practised formative assessments, it seems that summative assessment in the context of RD is only minimally covered within the educational curriculum. The program should support students to perform investigations on the developed product in terms of user experience and actual impacts on individuals, society or the environment. Such assessments should take place both before and after the product is developed, released or put into actual use by consumers. Considering that under the university setting there are many restrictions to students' design being actualized and released to the market, it may be a good option to provide students with internship opportunities to be in the field of work that the design is for, conducting research, developing, and iteratively evaluating and modifying the design across different stages of the product life cycle. Doing so will also strengthen the principle of Multidisciplinary collaboration in that the student may work with cross-disciplinary colleagues in product design and development.

To conclude, our main recommendations are that i) activities of anticipating societal consequences of design could be guided by using existing tools in a structured manner; ii) there should be more active participation of stakeholders; and iii) if conditions permit, involve summative responsible assessments of design outcomes.

4.3.2 Psychology Programme

The aspects of Reflexivity and context, Awareness of societal consequences, Value sensitivity and Responsible assessment strategy appear to receive relatively more focus compare to IDE. Nevertheless, the content of the courses is mainly on a conceptual level as responsible design is currently treated as a case of skills application in the context of the discipline of psychology. This also leaves room for pedagogical improvement. For example, although actualizing the design idea is not mandatory, requirement specification can be taught along with the use of developed tools to organize the thinking and analyses of user needs, values and context (e.g., use of card sorting and context mapping).

The elements of Participation and Multidisciplinary collaboration, although mostly implemented within design projects but yet not a requirement for the psychology curriculum, can still find their place in elective courses on RD. Perhaps in higher grades for instance the second half of the second year or the third year, students can take an elective course opened specifically for Psychology students who are interested in product design. They can take advantage of the course to study RD systematically and explore how to incorporate psychological theories in RD practice.

Our major suggestion is that tools or methods used in design practice could be taught in various courses or modules, to instruct Psychology students to define the problem, to organize their thoughts and to better communicate concepts/ideas.

5 General Discussion

The current work included three phases: a systematic review of RD literature, a case study on a real-world responsible innovation project, and a review of two bachelor programmes of the University of Twente. The literature review aimed at acquiring a fuller view of the research and practice of RD. With the outcomes of the review, we identified gaps associated with the operationalisation of the RD principles and accordingly proposed a working Framework of Responsible Design Practice (FRDP) to bridge the gaps. The case study on Stad-up was intended as a way to learn how RD was implemented in a real project by also applying the FRDP as a tool to review the project and redesign the framework based on the lessons learned. Finally, the review of the programmes provided by UT identifies potential improvement directions for RD education provided by the programmes. The thesis, to our knowledge, is the first work that systematically reviews extant RD literature to propose a unified framework of design practice that encompasses both principles of RD and methods that can be used to execute such principles. The framework we are proposing could serve as a

benchmark for assessing RD projects as well as a tool to review and promote the inclusion of RD in educational programmes.

Looking at a broader context, nowadays, the awareness around key social issues and the impact of design on the environment and humans in their society has extended beyond design theory and industry practice to the domain of social innovation, governance and policymaking. For example, the European Commission (2014) introduced the concept of Responsible Research and Innovation which accentuates "the (ethical) acceptability, sustainability and societal desirability" of the research and innovation process (Burget, Bardone, & Pedaste, 2017). Outside the domains of engineering, design and psychology we see the need for RD. However, there is limited attention to it in education. This study therefore contributes to the potential establishment of a universal guideline or framework for shaping education that can account for sustainable development of society in large.

Four main limitations of the present work should be acknowledged. Firstly, concerning the literature review, we did not implement any inter-coder reliability protocol as requested by the PRISMA framework. This might have compromised the reliability and precision of the findings especially those concerning numbers and percentages. Secondly, due to our specific interest in areas of product and interaction design, we limited our literature search scope to only some of the numerous design domains. This means that we might have missed some useful items and frameworks outside the digital domain. Perhaps many studies did not exclusively focus on RD, so maybe these design methods were not always used for RD practice but a 'conventional' design case. Thirdly, regarding the case study, by acting as a reviewer of the previous work we only had secondary data on the previous user research and service development instead of first-hand information. However, we added to the original information by performing the survey and interview with current and potential users. Finally, our approach to identifying the gaps and improvement opportunities in RD education

provided by the two UT programs was only carried out using available information on the University websites and on OSIRIS platform. Future studies are needed to enrich our findings by employing other techniques such as involving expert (e.g., teaching staff) in interview and survey to reviewing the curricula under the light of the FRDP.

References

Anagnostopoulou, E., Bothos, E., Magoutas, B., Schrammel, J., & Mentzas, G. (2018). Persuasive technologies for sustainable mobility: State of the art and emerging trends. *Sustainability*, *10*(7), 2128.

Artefact Group. (n.d.). *The Tarot Cards of Tech*. Artefact Group. http://tarotcardsoftech.artefactgroup.com/

Ashour, A. F. (2020). Design responsibility and sustainability in education. International *Journal of Design and Nature and Ecodynamics*, *15*(1), 129-133. doi:10.18280/ijdne.150117

Baxter, K., Courage, C., & Caine, K. (2015). *Understanding your users: a practical guide to user research methods*. Morgan Kaufmann.

Bennett, A. G., Cassim, F., & van der Merwe, M. (2017). How Design Education Can Use Generative Play to Innovate for Social Change: A Case Study on the Design of South African Children's Health Education Toolkits. *International Journal of Design, 11*(2), 57-72. Retrieved from https://search.proquest.com/docview/2170591010?accountid=106781

Bissett-Johnson, K., & Radcliffe, D. F. (2021). Engaging engineering students in socially responsible design using global projects. *European Journal of Engineering Education*, *46*(1), 4-26. https://doi.org/10.1080/03043797.2019.1674785

Boehm, S. (2015). Facilitating comprehension, connection and commitment to environmentally responsible design. *International Journal of Art and Design Education, 34*(1), 73-88. doi:10.1111/jade.12010

Borsci, S., Federici, S., Bacci, S., Gnaldi, M., & Bartolucci, F. (2015). Assessing user satisfaction in the era of user experience: comparison of the SUS, UMUX, and UMUX-LITE as a function of product experience. *International Journal of Human-*

Computer Interaction, *31*(8), 484-495. https://doi.org/10.1080/10447318.2015.1064648

Burget, M., Bardone, E., & Pedaste, M. (2017). Definitions and conceptual dimensions of responsible research and innovation: A literature review. *Science and engineering ethics*, *23*(1), 1-19. doi: 10.1007/s11948-016-9782-1

Cipolla, C., & Bartholo, R. (2014). Empathy or inclusion: A dialogical approach to socially responsible design. *International Journal of Design*, *8*(2).

Devecchi, A., & Guerrini, L. (2017). Empathy and Design. A new perspective. *The Design Journal, 20*(sup1), 4357. http://dx.doi.org/10.1080/14606925.2017.1352932

de Vere, I., Bissett-Johnson, K., & Thong, C. (2009). Educating the responsible engineer; socially responsible design and sustainability in the curriculum. In *DS 59: Proceedings of E&PDE 2009, the 11th Engineering and Product Design Education Conference-Creating a Better World, Brighton, UK, 10.-11.09. 2009*.

Dutta, U. (2019). Design Engagements at the Margins of the Global South: De-Centering the "Expert" Within Me. *Sustainability, 11*(20), 5675. doi:http://dx.doi.org/10.3390/su11205675

Eggink, W. (2020). Cultivating Responsible Design with the Product Impact Tool. In DS 104: Proceedings of the 22nd International Conference on Engineering and Product Design Education (E&PDE 2020), VIA Design, VIA University in Herning, Denmark. 10th-11th September 2020.

Eggink, W., Ozkaramanli, D., Zaga, C., & Liberati, N. (2020). *Setting the stage for Responsible Design*. In Design Research Society, DRS 2020: Synergy (pp. 713-730). Design Research Society. https://doi.org/10.21606/drs.2020.116

European Commission (EC). (2014). Responsible Research and Innovation. Europe's Ability to Respond to Societal Challenges. Retrieved from https://ec.europa.eu/research/swafs/pdf/pub_rri/KI0214595ENC.pdf

Friedman, B., Kahn, P., & Borning, A. (2002). Value sensitive design: Theory and methods. *University of Washington technical report*, (2-12). Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.11.8020&rep=rep1&type=pdf

Friedman, B., Hendry, D. G., & Borning, A. (2017). A survey of value sensitive design methods. *Foundations and Trends in Human-Computer Interaction*, *11*(2), 63-125. https://doi.org/10.1561/1100000015

Grimpe, B., Hartswood, M., & Jirotka, M. (2014, April). Towards a closer dialogue between policy and practice: responsible design in HCI. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 2965-2974). https://doi.org/10.1145/2556288.2557364

Haug, A. (2017). Educating ethical designers. *International Journal of Technology and Design Education, 27*(4), 655-665. http://dx.doi.org/10.1007/s10798-016-9367-y

Hernandez, R. J., & Goñi, J. (2020). Responsible Design for Sustainable Innovation: Towards an Extended Design Process. *Processes*, *8*(12), 1574.

Hill, A. M. (1998). Problem solving in real-life contexts: An alternative for design in technology education. *International journal of technology and design education*, *8*(3), 203-220. https://doi.org/10.1023/A:1008854926028

Ind.ie. (2017). Ethical Design. Ind.ie. https://2017.ind.ie/ethical-design/

IDEO. (2015). *Human Centered Design Tool Kit*. IDEO. Retrieved from https://www.ideo.com/post/design-kit

INC. (2019). Stadup IN BEWEGING IN MOBILITEIT. INC. https://ontwerpbureauinc.nl/cases/stadup/

International Organization for Standardization. (2016). *Environmental management — Life cycle assessment — Principles and framework*. Retrieved from https://www.iso.org/standard/37456.html

International Organization for Standardization. (2016). *Ergonomics of human-system interaction — Part 11: Usability: Definitions and concepts* (ISO Standard No. 9241). Retrieved from https://www.iso.org/obp/ui/#iso:std:iso:9241:-11:ed-2:v1:en

International Organization for Standardization/International Electrotechnical Commission. (2011). *Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — System and software quality models* (ISO/IEC Standard No. 25010). Retrieved from https://www.iso.org/obp/ui/#iso:std:iso-iec:25010:ed-1:v1:en

Jones, L. (2008). *Environmentally responsible design: Green and sustainable design for interior designers*. John Wiley & Sons.

Keitsch, M. (2012). Sustainable Design: A Brief Appraisal of its Main Concepts. *Sustainable Development, 20*(3), 180-188. doi:10.1002/sd.1534

Koo, Y. (2016). The role of designers in integrating societal value in the product and service development processes. *International Journal of Design*, *10*(2), 49-65. Available online http://138.68.228.161/index.php/IJDesign/article/view/2462

Kuure, E., & Miettinen, S. (2017). Social Design for Service. Building a Framework for Designers Working in the Development Context. *Design Journal, 20*(sup1), S3464-S3474. doi:10.1080/14606925.2017.1352850

Leeuwis, C., Cieslik, K. J., Aarts, M. N. C., Dewulf, A. R. P. J., Ludwig, F., Werners, S. E., & Struik, P. C. (2018). Reflections on the potential of virtual citizen science platforms to

address collective action challenges: Lessons and implications for future research. *NJAS - Wageningen Journal of Life Sciences, 86-87*, 146-157. doi:10.1016/j.njas.2018.07.008

Letens, G. (2015). Lean Product Development—Faster, Better… Cleaner? *Frontiers of Engineering Management, 2*(1), 52-59.

Li, Y., & Voege, T. (2017). Mobility as a service (MaaS): Challenges of implementation and policy required. *Journal of transportation technologies*, *7*(2), 95-106. doi: 10.4236/jtts.2017.72007

Lie, I. K. (2016). 'Make Us More Useful to Society!': The Scandinavian Design Students' Organization (SDO) and Socially Responsible Design, 1967–1973. *Design and Culture*, *8*(3), 327-361.

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P., ... & Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *Journal of clinical epidemiology*, *62*(10), e1-e34. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.689.2699

Lutnćs, E. (2017). *Responsible creativity in design education.* Paper presented at the DS 88: Proceedings of the 19th International Conference on Engineering and Product Design Education (E&PDE17), Building Community: Design Education for a Sustainable Future, Oslo, Norway, 7 & 8 September 2017.

Machado, C. A. S., de Salles Hue, N. P. M., Berssaneti, F. T., & Quintanilha, J. A. (2018). An overview of shared mobility. *Sustainability*, *10*(12), 4342. https://doi.org/10.3390/su10124342

Margolin, V., & Margolin, S. (2002). A "social model" of design: Issues of practice and research. *Design issues*, *18*(4), 24-30. https://doi.org/10.1162/074793602320827406

McMahon, M., & Bhamra, T. (2017). Mapping the journey: visualising collaborative experiences for sustainable design education. *International Journal of Technology and Design Education, 27*(4), 595-609. doi:10.1007/s10798-016-9365-0

Melles, G., de Vere, I., & Misic, V. (2011). Socially responsible design: thinking beyond the triple bottom line to socially responsive and sustainable product design. *CoDesign*, *7*(3-4), 143-154. https://doi.org/10.1080/15710882.2011.630473

Mink, A., van der Marel, F., Parmar, V., & Kandachar, P. (2015). Approaching design for development from a capability perspective. *Current Science, 109*(9), 1639-1650. Retrieved from http://www.jstor.org/stable/24906187

Morley, J., & Floridi, L. (2020). The Limits of Empowerment: How to Reframe the Role of mHealth Tools in the Healthcare Ecosystem. *Science and Engineering Ethics, 26*(3), 1159-1183. doi:10.1007/s11948-019-00115-1

Namahn, & Flanders DC. (2019). *An introduction to the methodology of service design*. Service Design Toolkit. https://www.servicedesigntoolkit.org/

Nascimento, S., xf, & lvora, A. (2013). Opening Up Technologies to the Social: Between Interdisciplinarity and Citizen Participation. *Design Issues, 29*(4), 31-40. Retrieved from http://www.jstor.org/stable/24266964

Nielson, Jakob. (1997, January 1). *The Use and Misuse of Focus Groups*. Nielson Norman Group. https://www.nngroup.com/articles/focus-groups/

Ozkaramanli, D. (2017). Me against Myself—Addressing Personal Dilemmas through Design. Ph.D. Thesis, Delft Institute of Positive Design, Delft, The Netherlands.

Ozkaramanli, D., Özcan, E., & Desmet, P. (2017). Long-Term Goals or Immediate Desires? Introducing a Toolset for Designing with Self-Control Dilemmas. *The Design Journal*, *20*(2), 219-238. https://doi.org/10.1080/14606925.2017.1272831

Papadopoulos, I., Koulouglioti, C., Lazzarino, R., & Ali, S. (2020). Enablers and barriers to the implementation of socially assistive humanoid robots in health and social care: a systematic review. *BMJ Open, 10*(1). doi:http://dx.doi.org/10.1136/bmjopen-2019-033096

Papanek, V. (1971). *Design for the real world: Human ecology and social change*. London: Thames & Hudson.

Papanek, V. (1985). *Design for the real world: Human ecology and social change*. Chicago, IL: Academy Chicago Publishers.

Peters, D., Ahmadpour, N., & Calvo, R. A. (2020). Tools for wellbeing-supportive design: Features, characteristics, and prototypes. *Multimodal Technologies and Interaction, 4*(3), 1-19. doi:10.3390/mti4030040

Ranisch, R., Nijsingh, N., Ballantyne, A., van Bergen, A., Buyx, A., Friedrich, O., . . . Wild, V. (2020). Digital contact tracing and exposure notification: ethical guidance for trustworthy pandemic management. *Ethics and Information Technology*. doi:10.1007/s10676-020-09566-8

Rose, E. J. (2016). Design as advocacy: Using a human- centered approach to investigate the needs of vulnerable populations. *Journal of Technical Writing and Communication, 46*(4), 427-445. doi:10.1177/0047281616653494

Salazar, Kim. (2020, December 6). *Contextual Inquiry: Inspire Design by Observing and Interviewing Users in Their Context*. Nielson Norman Group. https://www.nngroup.com/articles/contextual-inquiry/

Sanders, E. B. N. (2002). From user-centered to participatory design approaches. In *Design and the social sciences* (pp. 18-25). CRC Press.

Sauro, J. (2011, February 2). Measuring Usability With the System Usability Scale (SUS). Measuring U. https://measuringu.com/sus/

Sawyer, K.R. (2015). *Zig Zag Creativity Card Deck*. KEITH SAWYER. http://keithsawyer.com/zzdeck/

Schrepp, M., Hinderks, A., & Thomaschewski, J. (2017). Design and Evaluation of a Short Version of the User Experience Questionnaire (UEQ-S). *Ijimai*, *4*(6), 103-108. doi: 10.9781/ijimai.2017.09.001

Stappers, P. J., Sleeswijk Visser, F., & van der Lugt, R. (2007). Teaching contextmapping to industrial design students. *Proceedings of include 2007*, 1-6. https://studiolab.ide.tudelft.nl/studiolab/sleeswijkvisser/files/2011/05/stapperssleeswijkvisser.pdf

Smith, C. E., & Karthaus, R. (2012). Design for life. *RSA Journal, 160*(5552), 34-37. Retrieved from https://www.jstor.org/stable/26204173

Sorice, M. G., & Donlan, C. J. (2015). A human-centered framework for innovation in conservation incentive programs. *Ambio, 44*(8), 788-792. Retrieved from http://www.jstor.org/stable/24670659

Steen, M. (2011). Tensions in human-centred design. CoDesign, 7(1), 45-60. https://doi.org/10.1080/15710882.2011.563314

UNESCO. (2018, September 3). *UN Decade of ESD*. https://en.unesco.org/themes/education-sustainable-development/what-is-esd/un-decade-of-esd

United Nations. (2015). *The 17 Sustainable Development Goals*. Retrieved fromhttps://sustainabledevelopment.un.org/?menu=1300

Utwente. (2019). *SIP-REPORT FACULTY BMS*. https://www.utwente.nl/en/bms/sdg/bms-sip-report-def-jan-2019.pdf

Appendix A

Table A1

PRISMA Checklist for the Systematic Literature Review

The focus	Peer-review articles and conference papers that include methods of implementing Responsible Design.
The goal	To integrate and generalize previous design and educational practices to discuss and strengthen the Responsible Design agenda.
Perspective	The language of the literature review will be neutral.
Coverage	The review will cover central or pivotal literature only.
Organization	The review will be organized around the proposition of exploring, mapping and defining how Responsible Design is implemented in design practice.
Audience	*Primary* – practitioners in design industry and academia.
Methodology	This literature review is qualitative and will follow the phenomenological of literature review.
Inclusion criteria	• Studies that are in the domain of product/service/industrial/interaction//experience/digital design or human factors. • Studies that mention responsible design in the title, abstract, keywords or main text. • Studies that include methods or methodological framework about conducting responsible design in practice • Studies from 2010 to 2020.
Exclusion criteria	• Studies in which responsible design is only referred to without any deeper explanation or further development or mentioned only in the references. • Studies whose domain of application of responsible design is outside the abovementioned fields (e.g., architecture, arts, biotechnology).

Search Inquiry—Web of Science	(TS = ("responsible design") AND TS = ("industrial " OR "interaction" OR "product" OR "service" OR "digital" OR "experience" OR "human factors")) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article) Timespan: 2010-2020. Indexes: SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, ESCI.
Search Inquiry—ProQuest	("responsible design") AND (industr* OR interaction OR product OR service OR digital OR experience OR "human factors") Additional limits – Date: From 2010 to 2020 Source type: Conference Papers & Proceedings, Scholarly Journals Document type: Article, Conference Paper Language: English
Search Inquiry—JSTOR	(("responsible design") AND (industr* OR interaction OR product OR service OR digital OR experience OR "human factors")) AND la:(eng OR en) PUBLICATION DATE: FROM 2010 TO 2020.
Search Inquiry—Scopus	TITLE-ABS-KEY (("responsible design") AND (industr* OR interaction OR product OR service OR digital OR experience OR "human factors")) AND DOCTYPE (ar OR co) AND PUBYEAR > 2009 AND PUBYEAR < 2021
Tools	Prisma Flow diagram, PRISMA 2009 Checklist (http://prisma-statement.org/)

Appendix B

Table B1

Complete List of the Identified Subject Areas in Responsible Design Literature

Subject area	Frequency
Socially responsible design	**31 (100.0%)**
Design education	**10 (32.3%)**
Sustainable design/sustainability	**10 (32.3%)**
Ethics	**7 (22.6%)**
Design for Development (DfD)	6 (19.4%)
Design for Community (DfC)	6 (19.4%)
Social innovation	5 (16.1%)
Design thinking	4 (12.9%)
Social justice and equality	3 (9.7%)
Empathy	3 (9.7%)
Social design	3 (9.7%)
Responsible Research and Innovation (RRI)	2 (6.5%)
Empowerment	1 (3.3%)
Systems-oriented design	1 (3.2%)
Future scenario development	1 (3.2%)
Responsible creativity	1 (3.2%)
Wellbeing-supportive design	1 (3.2%)

Note. N_{items} = 31. Frequency is a relative percentage, i.e., the percentage of items in the review specify a particular subject area.

Table B2

Frequency Table of the Approaches to Responsible Design Identified From all Reviewed Articles

Approach	Frequency
Participatory design	**15 (48.4%)**
Multidisciplinary approach	**11 (35.5%)**
Co-design	**10 (32.3%)**
Formative assessments (iterations)	**9 (29.0%)**
HCD	6 (18.8%)
Social design	5 (16.1)%
Design for social innovation/Social innovation (SI)	4 (12.9%)
Design ethnography	4 (12.9%)
Design thinking	4 (12.9%)
Inclusive/Universal design	4 (12.9%)
VSD	3 (9.7%)
Emphatic design	3 (9.7%)
Ethical design	3 (9.7%)
Transformation design	3 (9.7%)
Capability approach	3 (9.7%)
Social model of design practice	3 (9.7%)
Ecological design/Eco-design	2 (6.7%)
Critical design (including Speculative design)	2 (6.7%)
Service design	2 (6.5%)
Appropriate technology	2 (6.5%)
Empowerment	2 (6.5%)
Systems design	2 (6.5%)
Open Script design	2 (6.5%)
Design activism	1 (3.2%)
Culturally sensitive design	1 (3.2%)
Dialogical approach	1 (3.2%)
Regenerative design	1 (3.2%)
Phenomenological framework	1 (3.2%)
Play	1 (3.2%)
Postconstructivisms	1 (3.2%)
UCD	1 (3.2%)
Dilemma driven design	1 (0.9%)

Note. N_{items} = 31; Frequency is a relative percentage, i.e., the percentage of items in the review specify a particular design approach.

VSD = Value-Sensitive Design; HCD = Human-Centred Design; SI = Social innovation/design for social innovation; UCD = User-Centred Design.

Table B3

Frequency Table of the Methods Identified From Reviewed Articles Mentioning Methods for Responsible Design

Design aid (n = 20)	Frequency
IDEO HCD Toolkit	6 (30%)
Interview (Semi-structured interview, group interview, In-depth interview)	5 (25%)
Design ethnography (participant observation, video diaries)	4 (20%)
Co-creation workshop/session	3 (15%)
Contextual inquiry	2 (10%)
Opportunity Detection Kit for qualitative inquiry	1 (5%)
Focus groups	1 (5%)
Reflective inquiry via GIGA Mapping	1 (5%)
Future scenario development	1 (5%)
The Product Impact Tool	1 (5%)
Stakeholder collaboration	1 (5%)
Anticipatory governance	1 (5%)
Biomimicry	1 (5%)
Life cycle analysis (LCA)	1 (5%)
Reflective inquiry	1 (5%)
Service Design Toolkit	1 (5%)
Zig Zag Creativity Card Deck	1 (5%)
Tarot Cards of Tech	1 (5%)
The Dilemma Co-Exploration Toolkit	1 (5%)
SDI tools	1 (5%)
Liz Sanders' MakeTools	1 (5%)
Generative play	1 (5%)

Note. N_{items} = 31; Frequency is a relative percentage, i.e., the percentage of items in the review specify a particular design aid (i.e., methods, tools and/or techniques).

Table B4

Summary of Design Aids That Support Responsible Design Implementation

Design Aids	Methods and Key references
Define the Brief : Frame your challenge *Purpose: involve stakeholders and co-define the problem*	A brief is referred to "a set of mental constraints that gives the project team a framework from which to begin, benchmarks by which they can measure progress, and a set of objectives to be realized—such as price point, available technology, and market segment" (Brown &Wyatt, 2010, p. 33). Define and redefine the brief with all stakeholders especially the key stakeholders. See IDEO (2015);
Ethnography: Participant observation *Purpose: explore and understand users' needs in context*	Get into the field to spend time (usually an extended time span) with the people you're designing for. Observe the people in their own living or work environment, and learn how and why they make decisions, what they feel, experience and expect. See IDEO (2015); Rose (2016);
Ethnography: Video diaries *Purpose: explore and understand users' needs in context*	A way to allow participants to guide the research process and to capture their day-in-the-life experience of using a specific product with a camera. See Rose (2016).
Ethnography: Shadowing (a form of Participant observation) *Purpose: explore and understand users' needs in context*	The best way to understand people is by immersing yourself in their lives and communities. Shadow a person you are designing for a day or for just a few hours. Have them walk you through how they make decisions, watch them socialize, work, and relax. See IDEO (2015).
Ethnography: Guided Tour *Purpose: explore and understand users' needs in context*	Take a guided tour through the home or workplace of the person you're designing for can reveal their habits and values. See IDEO (2015).
One-on-one interview *Purpose: explore and understand users' needs*	Individual interview conducted to get to the people you're designing for and hear from them in their own words. A way to learn much about a person's mindset, behaviour, and lifestyle by talking with them. See IDEO (2015).

Group interview *Purpose: explore and understand users' needs*	Learn quickly what is valuable to a community, their life, dynamics, and needs by having direct conversation with a group of people. Focus group is one form of group interview conducted to discover what people think or feel about a particular topic and what they want from the system. See Nielson (1997); IDEO (2015).
Contextual inquiry *Purpose: explore and understand users' needs in context*	Observe and interview people in the their own environment (usually their home or place of business) to obtain information about the context of use. A way to discover unanticipated things and uncover low-level details that have become habitual and invisible. See IDEO (2015); Salazar (2020).
Contextmapping *Purpose: co-create and reconstruct context, uncover user needs and wants on a deeper level*	A creative process where users in a session, to "construct a view on the context", make designerly artifacts like drawings, collages and models, to map out their past and present experience with a product, and expressing their dreams. The map holds the elicited information and information about users' explicit feelings and knowledge as well as the tacit knowledge and latent needs to be fulfilled in the future. See Visser, Stappers, Van der Lugt, R., & Sanders, 2005).
Co-design workshop/Co-creation session *Purpose: explore and co-create solutions*	The design team along with users, who are treated also as designers or partners, create things together in a workshop, jointly exploring ideas, making and discussing sketches, playing with mock-ups and prototypes. See Eggink et al. (2020); IDEO (2015); Sanders and Stappers (2008)
Generative play *Purpose: explore and co-create solutions*	A system of designing where designers and the target community, engage in several forms of play (e.g., mastery play, dramatized play, free play, creative play, and biblio play), to design a combination of tangible and intangible outcomes. See Bennett et al. (2017).
Role playing *Purpose: make prototypes; develop empathy for users*	A type of prototype that is built by acting out an idea or experience to make it just tangible enough to elicit a response from others. Role-playing is usually performed based on data captured from careful observations of users. It is a good way to develop empathy for users. See IDEO (2015); Steen (2011).

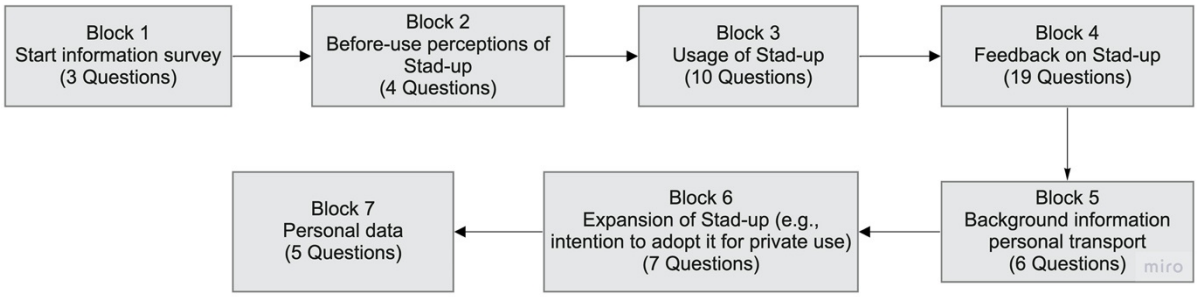
Rapid prototyping and Iterate *Purpose: make prototypes and test them in time*	Make the generated concepts or ideas tangible by using prototypes (e.g., Storyboards, Role Playing, models or mock-ups) and then test them and build new ones based on feedback, and repeat this process until it is just right. See IDEO (2015)
Future scenario development *Purpose: situate the problem systematically; anticipate future impacts of design*	Scenarios are explicit descriptions of hypothetical use situations (van der Bijl-Brouwer & van der Voort, 2009). Develop explorative future scenarios and contemplate on the different impacts a particular product or technology will have on human society in these future context scenarios. See Eggink (2020).
Participatory scenario generation *Purpose: situate the problem systematically; anticipate future impacts of design*	Scenarios are explicit descriptions of hypothetical use situations. Scenario-based specifications indicate product behaviour in terms of what a user in a certain context can do and how it will interact. There are two types of participatory scenario generation: direct and indirect. Directly generated scenarios are created together with users. Indirect generated scenarios are created by designers using common analysis techniques like observations and interviews. See van der Bijl-Brouwer & van der Voort (2009).
Multidisciplinary collaboration *Purpose: involve stakeholders; synthesize cross-domain knowledge and expertise; get various perspectives*	Collaboration between disciplines. Experts from multiple areas and disciplines are involved in every stage of the design process. For a guide to build a multidisciplinary team, see the IDEO's Field Guide to Human Centred Design (2015); also refer to McMahon and Bhamra's work (2017) for how to effectively implement Multidisciplinary team work in education.
Card sorting *Purpose: explore users' needs, wants and expectations*	Identify what's most important to the people you're designing for and why by having them to rank a deck of cards in order of preference. It can be done in different posed scenarios to expand the exploration of more contexts. See IDEO (2015).
Zig Zag Creativity Card Deck *Purpose: ideate and co-create solutions*	A card deck aimed for generating ideas and creating solutions. See Sawyer (2015).

Liz Sanders' MakeTools *Purpose: uncover users' wants, needs and expectations on a deeper level; Co-create solutions*	A generative tool set that can both be used in the exploration and definition phase to uncover the (latent) needs, wants and values of the people you are designing for, and be used in the ideation phase where designers and their user partners co-create things in a workshop. See Sanders (n.d.).
Opportunity Detection Kit for qualitative inquiry (ODK) *Purpose: explore, ideate and co-create solutions*	A method designers can use when conducting semi-structured interviews with potential users. The Kit helps the designer to detect design opportunities by means of questioning users about all aspects of lives instead of focusing on the product itself. See Mink, van der Marel, Parmar, & Kandachar (2015).
Service Design Toolkit *Purpose: co-explore problems; Co-create solutions*	A toolkit for service design that designers can use in the workshop setting. See find & Flanders (2019).
Tarot Cards of Tech *Purpose: anticipate and assess the impact of the design*	A card deck that can help designers anticipate and appraise the impacts of their design creation in the future context. See Artefact Group (n.d.).
Reflective Inquiry via GIGA Mapping *Purpose: situate the problem systematically; anticipate future impacts of design*	Reflect on a product or service by putting it in the socio-ecological context and mapping out the relationships and complexity of creating with the use of visualizations including images and text. It is especially suitable to systems-oriented design. See Lutnćs (2017).
The Product Impact Tool *Purpose: Anticipate and assess the impact of the design*	A framework used to anticipate and assess the four different types of impacts of technology or the resulting design will have on the society, namely, before-the-eye, to-the-hand, behind-the-back, and above-the-head. See Eggink (2020).

Appendix C

Figure C1

Flow of Survey for Current Users



Survey questions to citizens:

Start of Block: Start survey

Q53 Beste deelnemer,

Hartelijk bedankt voor het open van de enquête!

Deze enquête is opgesteld door de University of Twente en is bedoeld voor medewerkers van de Gemeente Enschede. Hierbij richt ze zich op de evaluatie van Stad-up. Door antwoord te geven op de vragen verzamelen wij waardevolle feedback en informatie voor het verbeteren en mogelijk uitbreiden van de Stad-up service. Hiervoor is het niet van belang of u al gebruik heeft gemaakt van de service Stad-up.

De enquête bestaat uit twee delen:
1) feedback op de huidige Stad-up service en 2) het verzamelen van informatie voor de mogelijke uitbreiding ervan.

Het invullen van deze enquête duurt zo'n 10 tot 15 minuten. Wij gaan vertrouwelijk om met uw

gegevens en antwoorden en deze worden volledig anoniem verwerkt. Mocht u vragen en/of opmerkingen hebben over dit onderzoek, dan kunt u contact opnemen met **info@stad-up.nl**.

Alvast bedankt voor uw deelname!

Q54 ***Instemmingsverklaring***

"Ik verklaar dat ik op vrijwillige basis deelneem aan dit onderzoek. Hierbij ben ik me ervan bewust dat ik het recht heb om elk moment de vragenlijst te beëindigen of dan wel mijn data terug te trekken uit het onderzoek zonder noodzaak van enige argumentatie. Deze enquête word uitgevoerd door de Universiteit Twente, die mijn data bundelen tot groepsniveau en evalueren. De conclusies hiervan worden gebruikt voor het verbeteren van Stad-up en gedeeld met de hierbij betrokken partijen (de Gemeente Enschede, Baan Twente en Strategisch ontwerpbureau INC). Mijn deelname is volledig anoniem en de resultaten zijn niet herleidbaar tot individuele meningen.

Voor vragen en/of opmerkingen kan in contact opnemen met **info@stad-up.nl**.

Ik heb bovenstaande tekst gelezen en begrepen."

Ik ga akkoord met deelname aan dit onderzoek.

- ○ Ja (1)
- ○ Nee (2)

Skip To: End of Survey If Instemmingsverklaring "Ik verklaar dat ik op vrijwillige basis deelneem aan dit onderzoek. Hierbi... = Nee

Q55 Beveiligingscheck

End of Block: Start survey

Start of Block: Verwachtingen Stad-up

Intro: Stad-up is het deelvervoersplatform van de Gemeente Enschede en wordt sinds begin 2019 gebruikt voor het werkverkeer van de werknemers van de Gemeente Enschede. De service bied aan de hand van richtlijnen over de weeromstandigheden en bereikbaarheid van de locatie de volgende mogelijkheden aan: Het gebruik van (elektrische) fietsen, het openbaar vervoer d.m.v. een NS Businesscard en elektrische deelauto's.

Let op: Gedurende deze enquête verwijzen we steeds naar het geheel van deze service als "Stad-up" vermeld wordt. Als het over een specifiek onderdeel gaat zoals de (elektrische) fietsen, de NS Businesscard en/of de elektrische deelauto's wordt dit explicitiet vermeld.

Onderstaande vragen zijn gericht op uw verwachtingen van Stad-up voor het gebruik van de service en implementatie door de Gemeente Enschede.

Q13 **Hoe stond u tegenover de invoering van Stad-up ter vervanging van de reiskosten vergoeding vanuit de Gemeente Enschede?**

- Zeer negatief (1)
- Negatief (2)
- Neutraal (3)
- Positief (4)
- Zeer positief (5)

Q15 **Keek u uit naar het gebruik van Stad-up?**

- Ja (1)
- Neutraal (2)
- Nee (3)

Q14 **Als u terugdenkt aan het moment waarop Stad-up voor het eerst aan u geïntroduceerd werd, welke scores op onderstaande aspecten geven dan het best uw mening van dat moment op Stad-up weer?**

	Stad-up is ...					
	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	
Belemmerend	○	○	○	○	○	Ondersteunend
Complex	○	○	○	○	○	Eenvoudig
Inefficiënt	○	○	○	○	○	Efficiënt
Verwarrend	○	○	○	○	○	Overzichtelijk
Vervelend	○	○	○	○	○	Spannend
Oninteressant	○	○	○	○	○	Interessant
Alledaags	○	○	○	○	○	Orgineel
Ouderwets	○	○	○	○	○	Nieuw

End of Block: Verwachtingen Stad-up

Start of Block: Gebruik Stad-up

De volgende vragen gaan over het gebruik van Stad-up.

Q21 **Heeft u gebruik gemaakt van de Stad-up?** Bij deze vraag gaat het zowel om de (elektrische) fietsen, het openbaar vervoer d.m.v. de NS Businesscard en de elektrische deelauto's.

- ○ Ja (1)
- ○ Nee (2)

Display This Question:

If Heeft u gebruik gemaakt van de Stad-up? Bij deze vraag gaat het zowel om de (elektrische) fietse... = Ja

Q17 **Van welke onderdelen van Stad-up heeft u gebruik gemaakt?**

- ☐ De (elektrische) fietsen (1)
- ☐ De NS Businesscard (2)
- ☐ De elektrische deelauto's (3)

Display This Question:

If Heeft u gebruik gemaakt van de Stad-up? Bij deze vraag gaat het zowel om de (elektrische) fietse... = Nee

Q50 **Waarom heeft u nog geen gebruik gemaakt van Stad-up?**

- ○ Gebruik niet nodig voor werkzaamheden (1)
- ○ Nog niet aan toegekomen (2)
- ○ Nog niet aan toegekomen door de huidige Covid-19 omstandigheden (3)
- ○ Het is me niet duidelijk hoe het gebruik van Stad-up werkt (4)
- ○ Ik voel me niet prettig met het gebruik van de Stad-up service (7)
- ○ Anders, namelijk: (6) _____

Display This Question:

If Waarom heeft u nog geen gebruik gemaakt van Stad-up? = Ik voel me niet prettig met het gebruik van de Stad-up service

Q51 **Waarom voelt u zich niet prettig bij het gebruik van de Stad-up service?**

_____

Display This Question:

If Waarom heeft u nog geen gebruik gemaakt van Stad-up? = Het is me niet duidelijk hoe het gebruik van Stad-up werkt

Q52 **Wat is voor u niet duidelijk aan de service?**

_____

Display This Question:

If Heeft u gebruik gemaakt van de Stad-up? Bij deze vraag gaat het zowel om de (elektrische) fietse... = Nee

Q54 **Van welke onderdelen van Stad-up verwacht u dat ze van past kunnen komen voor u werkverkeer?**

- ☐ De (elektrische) deelfietsen (1)
- ☐ De NS Businesscard (2)
- ☐ De elektrische deelauto's (3)

Display This Question:

If Heeft u gebruik gemaakt van de Stad-up? Bij deze vraag gaat het zowel om de (elektrische) fietse... = Ja

Q22 **Hoevaak heeft u in totaal gebruik gemaakt van de verschillende onderdelen?**

	Nooit gebruikt (1)	1 tot 5 keer (2)	6 tot 10 keer (3)	meer dan 10 keer (4)
De (elektrische) fietsen (1)	○	○	○	○
De NS Businesscard (2)	○	○	○	○
De elektrische deelauto's (3)	○	○	○	○

Display This Question:

If Van welke onderdelen van Stad-up heeft u gebruik gemaakt? = De NS Businesscard

And Van welke onderdelen van Stad-up heeft u gebruik gemaakt? = De (elektrische) fietsen

Or Van welke onderdelen van Stad-up heeft u gebruik gemaakt? = De NS Businesscard

Or Van welke onderdelen van Stad-up heeft u gebruik gemaakt? = De (elektrische) fietsen

Q50 **Waarom heeft u nog geen gebruik gemaakt van de elektrische deelauto's?**

- ○ Gebruik niet nodig voor werkzaamheden (1)
- ○ Nog niet aan toegekomen (2)
- ○ Nog niet aan toegekomen door de huidige Covid-19 omstandigheden (3)
- ○ Het is me niet duidelijk hoe het gebruik van de elektrische deelauto werkt (4)
- ○ Ik voel me niet prettig met het gebruik van de elektrische deelauto (5)
- ○ Anders, namelijk: (6) _____

Display This Question:

If Heeft u gebruik gemaakt van de Stad-up? Bij deze vraag gaat het zowel om de (elektrische) fietse... = Ja

Stad-up is ...

Q49 **Wat is uw algemene ervaring met het gebruik van Stad-up?**

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	
Belemmerend	○	○	○	○	○	Ondersteunend
Complex	○	○	○	○	○	Eenvoudig
Inefficiënt	○	○	○	○	○	Efficiënt
Verwarrend	○	○	○	○	○	Overzichtelijk
Vervelend	○	○	○	○	○	Spannend
Oninteressant	○	○	○	○	○	Interessant
Alledaags	○	○	○	○	○	Orgineel
Ouderwets	○	○	○	○	○	Nieuw

End of Block: Gebruik Stad-up

Start of Block: Feedback Stad-up

De volgende vragen gaan over het verbeteren van de Stad-up service.
Hierbij werken we met 3 categorieën: 1) middelen, 2) operationeel en 3) ervaringen.

Probeer constructieve feedback te geven en oplossingsgericht te antwoorden;
wij waarderen uw feedback en hopen hiermee Stad-up te kunnen verbeteren.

1. Middelen

Denk hierbij aan alles wat te maken heeft met de faciliteiten en middelen zoals bijvoorbeeld de applicatie, de (elektrische) fietsen en elektrische deelauto's maar bijvoorbeeld ook aan de laadpalen en andere benodigde middelen tijdens het gebruik van de service.

Display This Question:

If Van welke onderdelen van Stad-up heeft u gebruik gemaakt? = De (elektrische) fietsen

Q24 **De (elektrische) fietsen**

Denk hierbij aan de verschillende aspecten van het gebruik van de fiets zoals 1) het reserveren, 2) het ophalen van de fiets, 3) het gebruik van de fiets en 4) het terugbrengen van de fiets.

- Wat moet beter? (1) _____
- Wat kan beter? (2) _____
- Wat is goed? (3) _____

Display This Question:

If Van welke onderdelen van Stad-up heeft u gebruik gemaakt? = De NS Businesscard

Q42 **De NS Businesscard**

- Wat moet beter? (1) _____
- Wat kan beter? (2) _____
- Wat is goed? (3) _____

Display This Question:

If Van welke onderdelen van Stad-up heeft u gebruik gemaakt? = De NS Businesscard

Q47 **Was u zich ervan bewust dat uw NS businesscard onderdeel is van de Stad-up service?**

- Ja (1)
- Nee (2)

Display This Question:

If Van welke onderdelen van Stad-up heeft u gebruik gemaakt? = De elektrische deelauto's

Q43 **De elektrische deelauto's**

Denk hierbij aan de verschillende aspecten van het gebruik van de elektrische deelauto zoals 1) het reserveren, 2) het ophalen van de auto, 3) het gebruik van de auto en 4) het terugbrengen van de auto.

- Wat moet beter? (1) _____
- Wat kan beter? (2) _____
- Wat is goed? (3) _____

Display This Question:

If Van welke onderdelen van Stad-up heeft u gebruik gemaakt? = De elektrische deelauto's

Q56 **Hoe is uw gebruikservaring met de app?**

- Zeer positief (1)
- Positief (2)
- Neutraal (3)
- Negatief (4)
- Zeer negatief (5)

De volgende vragen gaan over het verbeteren van de Stad-up service.
Hierbij werken we met 3 categorieën: 1) middelen, 2) operationeel en 3) ervaringen.
Probeer constructieve feedback te geven en oplossingsgericht te antwoorden; wij waarderen uw feedback en hopen hiermee Stad-up te kunnen verbeteren.

Q30 **2. Operationeel**

Denk hierbij aan hoe het concept werkt in de praktijk. Hoe ervaart u de stappen die u moet doorlopen bij het gebruik van een (elektrische) fiets; het plaatsen van een reservering voor de elektrische deelauto of de ervaringen met de elektrische deelauto's in gebruik.

Display This Question:

If Van welke onderdelen van Stad-up heeft u gebruik gemaakt? = De (elektrische) fietsen

Q44 **De (elektrische) fietsen**

Denk hierbij aan de verschillende aspecten van het gebruik van de fiets zoals 1) het reserveren, 2) het ophalen van de fiets, 3) het gebruik van de fiets en 4) het terugbrengen van de fiets.

- ○ Wat moet beter? (1) _____
- ○ Wat kan beter? (2) _____
- ○ Wat is goed? (3) _____

Display This Question:

If Van welke onderdelen van Stad-up heeft u gebruik gemaakt? = De NS Businesscard

Q45 **De NS Businesscard**

- Wat moet beter? (1) _____
- Wat kan beter? (2) _____
- Wat is goed? (3) _____

Display This Question:

If Van welke onderdelen van Stad-up heeft u gebruik gemaakt? = De elektrische deelauto's

Q46 **De elektrische deelauto's**

Denk hierbij aan de verschillende aspecten van het gebruik van de elektrische deelauto zoals 1) het reserveren, 2) het ophalen van de auto, 3) het gebruik van de auto en 4) het terugbrengen van de auto.

- Wat moet beter? (1) _____
- Wat kan beter? (2) _____
- Wat is goed? (3) _____

Q40 **Heeft u al eens gebruik moeten maken van de helpdesk van Stad-up?**

- Ja (1)
- Nee (2)

Display This Question:

If Heeft u al eens gebruik moeten maken van de helpdesk van Stad-up? = Ja

Q41 **Hoe was uw ervaring met de helpdesk?**

- Zeer positief (1)
- Positief (2)
- Neutraal (3)
- Negatief (4)
- Zeer negatief (5)

Display This Question:

If Heeft u al eens gebruik moeten maken van de helpdesk van Stad-up? = Ja

Q54 **Wilt u hier nog wat over toelichten?**

_____

De volgende vragen gaan over het verbeteren van de Stad-up service.
Hierbij werken we met 3 categorieën: 1) middelen, 2) operationeel en 3) ervaringen.
Probeer constructieve feedback te geven en oplossingsgericht te antwoorden; wij waarderen uw feedback en hopen hiermee Stad-up te kunnen verbeteren.

3. Ervaringen

Welke gedragsveranderingen die Stad-up met zich meebracht hadden het meest impact op uw werk en privé leven?

Q40 **Positieve ervaringen**

Welke positieve ervaringen heeft u van Stad-up?

_____

_____

Q36 **Negatieve ervaringen**

Welke negatieve ervaringen heeft u van Stad-up?

_____

_____

End of Block: Feedback Stad-up

Start of Block: Achtergrond informatie persoonlijk transport

De volgende vragen zijn gericht op de uitbreiding van de Stad-up service voor privé gebruik.
We willen u vragen om bij het beantwoorden van deze vragen uit te gaan van een situatie vóór de uitbraak van Covid-19.

Q1 **Uit hoeveel personen bestaat uw huishouden?**

- 1 persoon (1)
- 2 personen (2)
- 3 personen (3)
- 4 personen (4)
- Meer dan 4 personen (5)

Q2 **Hoeveel personen in uw huishouden beschikken over een rijbewijs?**

- Geen enkele persoon (1)
- 1 persoon (2)
- 2 personen (3)
- Meer dan 2 personen (4)

Q3.1 **Over hoeveel personenauto's beschikt uw huishouden?**

- 0 (1)
- 1 (2)
- 2 (3)
- Meer dan 2 (4)

Display This Question:

If Over hoeveel personenauto's beschikt uw huishouden? = 1

Or Over hoeveel personenauto's beschikt uw huishouden? = 2

Or Over hoeveel personenauto's beschikt uw huishouden? = Meer dan 2

Q3.2 **Beschikt u over een elektrische auto?**

- Ja (1)
- Nee (2)

Q4 **Had u ervaring met het gebruik van elektrische auto's vóór het gebruik van Stad-up?**

- Ja (1)
- Nee (2)

End of Block: Achtergrond informatie persoonlijk transport

Start of Block: Uitbreiding Stad-up

De volgende vragen zijn gericht op de uitbreiding van de Stad-up service voor privé gebruik.
We willen u vragen om bij het beantwoorden van deze vragen uit te gaan van een situatie vóór de uitbraak van Covid-19.

Q57 **Maakt u gebruik van of heeft u ervaring met een deelmobiliteitsysteem zoals Carsharing, MyWheels, Greenwheels of een vergelijkbare service?**

- ○ Ja (1)
- ○ Nee (2)

Q47 **Rank alstublieft de onderstaande aspecten van deelvervoer in volgorde van belangrijkheid voor u persoonlijk, waarbij 1 het meest belangrijk is en 7 het minst belangrijk.**

U kunt slepen met uw cursor en daarmee de aspecten op de juiste volgorde zetten.

_____ **Beschikbaarheidsgarantie van het deelvervoer** De garantie dat er altijd gebruik kan maken van het deelvervoer op het moment dat u deze nodig heeft. (1)

_____ **Parkeermogelijkheden bij terugkomst** De verplichting om op dezelfde plaats de auto in te leveren of juist niet. (2)

_____ **Verzekering & eigen risico** De voorwaarden vanuit de service bij mogelijke schade en/of verkeersongelukken. (3)

_____ **Kosten deelvervoer - kilometerkosten** De prijs van de afgelegde afstand met het deelvervoer. (4)

_____ **Kosten deelvervoer - mogelijke abonnementskosten** De prijs van mogelijke abonnementskosten voor gebruik van de deelvervoer service. (5)

_____ **Bereikbaarheid deelvervoer** De loop- of fietsafstand die u af moet leggen voor u gebruik kan maken van het deelvervoer. (6)

_____ **Aanbod deelvervoer** Het aanbod van verschillende voertuigen en transportmiddelen binnen de service. (7)

Q51 **Zou u gebruik willen maken van de Stad-up service voor privé gebruik?**

- ○ Ja (2)
- ○ Nee (3)

Display This Question:

If Zou u gebruik willen maken van de Stad-up service voor privé gebruik? = Nee

Q56 **Waarom zou u geen privé gebruik willen maken van de Stad-up service?**

_____

Display This Question:

If Zou u gebruik willen maken van de Stad-up service voor privé gebruik? = Nee

Q52 **Wat zou er moeten veranderen aan de Stad-up service zodat deze wel aantrekkelijk wordt voor privé gebruik ?**

_____

_____

Display This Question:

If Zou u gebruik willen maken van de Stad-up service voor privé gebruik? = Ja

Q46 **Wat zou er nog aangepast kunnen worden aan Stad-up om de service aantrekkelijker te maken voor privé gebruik?**

_____

_____

End of Block: Uitbreiding Stad-up

Start of Block: Persoonlijke data

Tot slot willen we u vragen om nog enkele vragen te beantwoorden die met u als persoon te maken hebben. Deze vragen zijn zo algemeen dat uit de antwoorden nooit de persoon kan worden afgeleid.

Q8 **Wat is de postcode van uw woonadres?**
Het gaat hierbij alleen om de 4 cijfers van u postcode

_____

Q7 **Wat is uw geslacht?**

- ○ Vrouw (1)
- ○ Man (2)
- ○ Anders (3)

Q6 **Wat is uw leeftijd?**

- ○ Jonger dan 25 jaar (1)
- ○ 25 - 45 jaar (2)
- ○ 46 - 65 jaar (3)
- ○ Ouder dan 65 jaar (4)

Q9 **Wat is uw hoogst behaalde opleidingsniveau?**

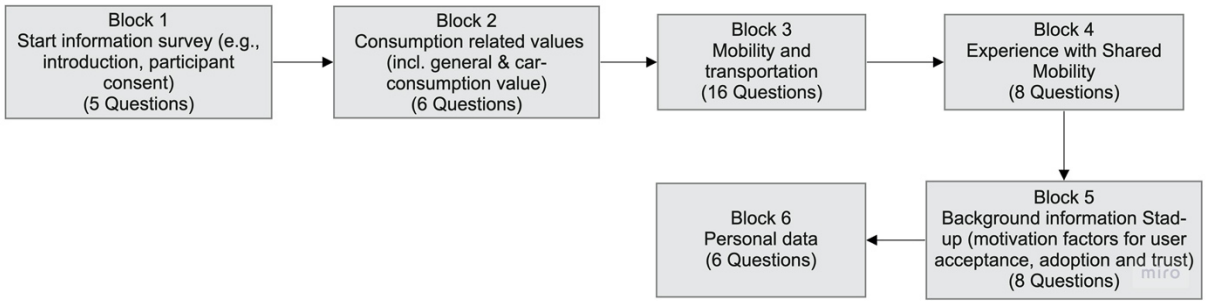
- ○ Geen opleiding/onvolledig basisonderwijs (1)
- ○ Basisschool (2)
- ○ Middelbaar (3)
- ○ Hoger beroepsonderwijs of technische hbo-opleiding (4)
- ○ Universitair bachelor diploma (5)
- ○ Universitair Masters diploma (6)
- ○ Universitair gespecialiseerd diploma (doctoraal, juridisch) (7)
- ○ Anders, namelijk.. (8) _____

End of Block: Persoonlijke data

Appendix D

Figure D1

Flow of Survey for Potential Users



Survey questions to citizens:

Start of Block: Start information survey

Q1 **Beste bewoner van Enschede,**

Hartelijk dank voor uw deelname!

Deze enquête is opgesteld door de Universiteit Twente en richt zich op de inwoners van het Binnensingelgebied van Enschede*. Maar wij ook de inwoners die nabij het centrum wonen uit om deel te nemen.

De enquête bestaat uit drie onderdelen:

1) Het eerste deel richt zich op de manier waarop u privé gebruik maakt van vervoer.

2) Het tweede deel vraagt naar uw ervaringen met deelmobiliteit.

3) Het laatste deel gaat over de mobiliteitsservice Stad-up; een deelmobiliteitssysteem van de Gemeente Enschede (uitleg van deze deze service volgt in de enquête).

Het invullen van deze enquête duurt zo'n 10 minuten. Wij gaan vertrouwelijk om met uw gegevens

en deze worden volledig anoniem verwerkt. Mocht u vragen en/of opmerkingen hebben over dit onderzoek, dan kunt u contact opnemen via info@stad-up.nl**.**

Alvast bedankt voor uw deelname!

** Buurten die binnen dit gebied vallen: Binnenstad, Larsonder-Zeggelt, Laares, De Bolthoven, Hogeland Noord, 't Getfert, Veldkamp-Getfert-West, Horstlanden-Stadsweide en Boddenkamp.*

Q2 **Instemmingsverklaring**

"Ik verklaar dat ik op vrijwillige basis deelneem aan dit onderzoek. Hierbij ben ik me ervan bewust dat ik het recht heb om elk moment de vragenlijst te beëindigen zonder noodzaak van enige argumentatie. Deze enquête word uitgevoerd door de Universiteit Twente, die mijn antwoorden bundelenmet andere deelnemers en evalueren. De conclusies hiervan worden gebruikt voor het mogelijk uitbreiden van de mobiliteit service Stad-up en gedeeld met de hierbij betrokken partijen (de Gemeente Enschede, Baan Twente en Strategisch ontwerpbureau INC). Mijn deelname is volledig anoniem en de resultaten zijn niet herleidbaar tot individuele meningen.

Voor vragen en/of opmerkingen kan in contact opnemen met info@stad-up.nl.

Ik heb bovenstaande tekst gelezen en begrepen."

Ik ga akkoord met deelname aan dit onderzoek.

- Ja (1)
- Nee (2)

Skip To: End of Survey If Instemmingsverklaring "Ik verklaar dat ik op vrijwillige basis deelneem aan dit onderzoek. Hier... = Nee

Q3 **Beveiligingcheck**

Q47 **Woont u in (of nabij) het Binnensingelgebied* van de stad Enschede?**

** Buurten die binnen dit gebied vallen: Binnenstad, Larsonder-Zeggelt, Laares, De Bolthoven, Hogeland Noord, 't Getfert, Velkamp-Getfert-West, Horstlanden-Stadsweide en Boddenkamp.*

- Ja (1)
- Nee (2)

Skip To: End of Survey If Woont u in (of nabij) het Binnensingelgebied van de stad Enschede? * Buurten die binnen dit geb... = Nee*

Q48 **Bent u 18 jaar of ouder?**

- Ja (1)
- Nee (2)

Skip To: End of Survey If Bent u 18 jaar of ouder? = Nee

End of Block: Start information survey

Start of Block: General Values

Geef van de volgende 2 stellingen aan hoe belangrijk de waarde hiervan voor u is bij de aanschaf van een product of service:

Q46 **Stelling 1: De duurzaamheid of het energielabel van een product of service.**

- Zeer onbelangrijk (1)
- Onbelangrijk (2)
- Enigszins onbelangrijk (3)
- Enigszins belangrijk (4)
- Belangrijk (5)
- Zeer belangrijk (6)

Q47 **Stelling 2: Het besparen van kosten met een product of een service.**

- Zeer onbelangrijk (1)
- Onbelangrijk (2)
- Enigszins onbelangrijk (3)
- Enigszins belangrijk (4)
- Belangrijk (5)
- Zeer belangrijk (6)

Geef van de volgende 2 stellingen aan in hoeverre u het eens bent met de stelling:

Q49 **Stelling 1: Het belangrijkste aan een personenauto is voor mij de functie als vervoersmiddel.**

- Zeer mee oneens (1)
- Mee oneens (2)
- Neutraal (3)
- Mee eens (4)
- Zeer mee eens (5)

Q52 **Stelling 2: Het merk en de uitvoering van mijn personenauto is voor mij belangrijk omdat dit wat zegt over mijn eigen imago.**

- Zee mee oneens (1)
- Mee oneens (2)
- Neutraal (3)
- Mee eens (4)
- Zeer mee eens (5)

End of Block: General Values

Start of Block: Mobility and Transportation

Q4 **Uit hoeveel personen bestaat uw huishouden?**

- 1 persoon (1)
- 2 personen (2)
- 3 personen (3)
- 4 personen (4)
- Meer dan 4 personen (5)

Q5 **Hoeveel personen in uw huishouden beschikken over een rijbewijs?**

- Geen enkele persoon (1)
- 1 persoon (2)
- 2 personen (3)
- Meer dan 2 personen (4)

Q6 **Over hoeveel personenauto's beschikt uw huishouden?**

- 0 (1)
- 1 (2)
- 2 (3)
- Meer dan 2 (4)

Display This Question:

If Over hoeveel personenauto's beschikt uw huishouden? != 0

Q7 **Hoe belangrijk is u auto voor uw dagelijkse verplaatsingen?**

*We willen u vragen bij het beantwoorden van deze vraag uit te gaan van de situatie **vóór** de uitbraak van Covid-19.*

- Zeer onbelangrijk (1)
- Onbelangrijk (2)
- Enigszins onbelangrijk (3)
- Enigszins belangrijk (4)
- Belangrijk (5)
- Heel belangrijk (6)

Display This Question:

If Over hoeveel personenauto's beschikt uw huishouden? != 0

Q8 **Beschikt u over een elektrische auto?**

- Ja (1)
- Nee (2)

Q9 **Heeft u ervaring met het gebruik van een elektrische auto?**

- Ja (1)
- Nee (2)

Q10 **Heeft uw een duidelijk beeld van de kosten die een auto jaarslijk met zich meebrengen?**

We willen u vragen bij het beantwoorden van deze vraag uit te gaan van de situatie vóór de uitbraak van Covid-19.

- Nee (1)
- Ja, namelijk.. (2) _____

Q50 **Hoeveel procent is dit van uw jaarlijkse inkomen?**

- Geen idee (1)
- Dat is ongeveer: (2) _____
- Dit zeg ik liever niet (3)

Q11 **Welke vervoersmiddelen heeft u (mogelijk naast uw persoonsauto) in uw bezit?**

- ☐ Fiets (1)
- ☐ Elektrische fiets (2)
- ☐ Scooter (3)
- ☐ Brommer (4)
- ☐ Motor (5)
- ☐ Anders, namelijk: (6) _____

Q13 **Van welke vervoersmiddelen maakt u het meest gebruik?**

We willen u vragen bij het beantwoorden van deze vraag uit te gaan van de situatie vóór de uitbraak van Covid-19.

- Fiets (1)
- Elektrische fiets (2)
- Scooter (3)
- Brommer (4)
- Motor (5)
- Auto (6)
- Anders, namelijk: (7) _____

Q15 **Maakt u wel eens gebruik van het openbaar vervoer (OV)?**

We willen u vragen bij het beantwoorden van deze vraag uit te gaan van de situatie vóór de uitbraak van Covid-19.

- Ja (1)
- Nee (2)

Q12 **Heeft u een openbaar vervoer (OV) abonnement?**

Hierbij wordt gedoeld op en OV abonnement voor persoonlijk gebruik, zoals bijvoorbeeld een persoonlijk OV-chipkaart. M.a.w. niet een OV abonnement dat alleen gebruikt kan worden voor werkverkeer.

- Ja (1)
- Nee (2)

Display This Question:

If Maakt u wel eens gebruik van het openbaar vervoer (OV)? We willen u vragen bij het beantwoorden v... = Ja

Q17 **Hoe vaak maakt u gebruik van het Openbaar Vervoer?**

We willen u vragen bij het beantwoorden van deze vraag uit te gaan van de situatie vóór de uitbraak van Covid-19.

- Nooit (1)
- Zelden (ongeveer 1 keer per maand) (2)
- Soms (ongeveer 2 of 3 keer per maand) (3)
- Vaak (wekelijks; minder dan 2 of 3 keer per week) (4)
- Heel vaak (elke dag) (5)

Display This Question:

If Maakt u wel eens gebruik van het openbaar vervoer (OV)? We willen u vragen bij het beantwoorden v... = Ja

Q16 **Van welke vormen van het Openbaar Vervoer maakt u gebruik?**

We willen u vragen bij het beantwoorden van deze vraag uit te gaan van de situatie vóór de uitbraak van Covid-19.

- Trein (1)
- Bus (2)
- Tram (3)
- Metro (4)
- Taxi (5)
- Anders, namelijk.. (6) _____

Display This Question:

If Maakt u wel eens gebruik van het openbaar vervoer (OV)? We willen u vragen bij het beantwoorden v... = Ja

Q18 **Als u denkt aan het huidige aanbod van Openbaar Vervoer binnen Enschede, welke scores op onderstaande aspecten geven dan het best uw mening weer?**

We willen u vragen bij het beantwoorden van deze vraag uit te gaan van de situatie vóór de uitbraak van Covid-19.

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	
Uitgebreid	•	•	•	•	•	Beperkt
Belemmerend	•	•	•	•	•	Ondersteunend
Complex	•	•	•	•	•	Eenvoudig
Inefficiënt	•	•	•	•	•	Efficiënt
Verwarrend	•	•	•	•	•	Overzichtelijk
Ouderwets	•	•	•	•	•	Vernieuwend

Q19 **Bent u tevreden over het algemeen genomen tevreden met de manier waarop u uw transporteert?**

We willen u vragen bij het beantwoorden van deze vraag uit te gaan van de situatie vóór de uitbraak van Covid-19.

- Zeer ontevreden (1)
- Enigszins ontevreden (2)
- Niet tevreden en niet ontevreden (3)
- Enigszins tevreden (4)
- Zeer tevreden (5)

End of Block: Mobility and Transportation

Start of Block: Experience Shared Mobility

Q26 **Heeft u wel eens gebruik gemaakt van een deelauto service, zoals bijvoorbeeld Carsharing, MyWheels, Greenwheels of een vergelijkbare service?**

- Ja (1)
- Nee (2)

Q27 **Wat vindt u van het gebruik van een deelauto?**

- Zeer negatief (1)
- Negatief (2)
- Neutraal (3)
- Positief (4)
- Zeer positief (5)

Display This Question:

If Heeft u wel eens gebruik gemaakt van een deelauto service, zoals bijvoorbeeld Carsharing, MyWheel... = Nee

Q28 **Heeft u wel eens nagedacht over het gebruik van een deelauto ?**

- Ja (1)
- Nee (2)

Display This Question:

If Heeft u wel eens gebruik gemaakt van een deelauto service, zoals bijvoorbeeld Carsharing, MyWheel... = Nee

Q29 **Zou u gebruik maken van een deelauto?**

- Ja (1)
- Nee (2)

Display This Question:

If Heeft u wel eens gebruik gemaakt van een deelauto service, zoals bijvoorbeeld Carsharing, MyWheel... = Nee

Q31 **Hieronder staan 7 verschillende aspecten van deelvervoer.**

Ondanks dat u aangeeft geen gebruik te hebben gemaakt van deelvervoer willen wij u vragen deze onderstaande aspecten te ranken in volgorde van belangrijkheid. Doe dit op de manier waarvan u denkt dat deze voor u het belangrijks zouden zijn bij het gebruik van deelvervoer, hierbij is 1 het meest belangrijk is en 7 het minst belangrijk.

U kunt slepen met uw cursor en daarmee de aspecten op de juiste volgorde zetten.

_____ **Beschikbaarheidsgarantie van het deelvervoer** De garantie dat er altijd gebruik kan maken van het deelvervoer op het moment dat u deze nodig heeft. (1)

_____ **Parkeermogelijkheden bij terugkomst** De verplichting om op dezelfde plaats de auto in te leveren of juist niet. (2)

_____ **Verzekering & eigen risico** De voorwaarden vanuit de service bij mogelijke schade en/of verkeersongelukken. (3)

_____ **Kosten deelvervoer - kilometerkosten** De prijs van de afgelegde afstand met het deelvervoer. (4)

_____ **Kosten deelvervoer - mogelijke abonnementskosten** De prijs van mogelijke abonnementskosten voor gebruik van de deelvervoer service. (5)

_____ **Bereikbaarheid deelvervoer** De loop- of fietsafstand die u af moet leggen voor u gebruik kan maken van het deelvervoer. (6)

_____ **Aanbod deelvervoer** Het aanbod van verschillende voertuigen en transportmiddelen binnen de service. (7)

Display This Question:

If Heeft u wel eens gebruik gemaakt van een deelauto service, zoals bijvoorbeeld Carsharing, MyWheel... = Ja

Q32 **Hoe vaak heeft u gebruik gemaakt van een deelauto systeem?**

- 1 keer (1)
- 2 tot 5 keer (2)
- 6 tot 10 keer (3)
- Meer dan 10 keer (4)

Display This Question:

If Heeft u wel eens gebruik gemaakt van een deelauto service, zoals bijvoorbeeld Carsharing, MyWheel... = Ja

Q33 **Wat zijn u redenen voor het gebruik van een deelauto?**

_____

_____

_____

Display This Question:

If Heeft u wel eens gebruik gemaakt van een deelauto service, zoals bijvoorbeeld Carsharing, MyWheel... = Ja

Q34 **Rank alstublieft de onderstaande aspecten van deelvervoer in volgorde van belangrijkheid voor u persoonlijk, waarbij 1 het meest belangrijk is en 7 het minst belangrijk.**

U kunt slepen met uw cursor en daarmee de aspecten op de juiste volgorde zetten.

_____ **Beschikbaarheidsgarantie van het deelvervoer** De garantie dat er altijd gebruik kan maken van het deelvervoer op het moment dat u deze nodig heeft. (1)

_____ **Parkeermogelijkheden bij terugkomst** De verplichting om op dezelfde plaats de auto in te leveren of juist niet. (2)

_____ **Verzekering & eigen risico** De voorwaarden vanuit de service bij mogelijke schade en/of verkeersongelukken. (3)

_____ **Kosten deelvervoer - kilometerkosten** De prijs van de afgelegde afstand met het deelvervoer. (4)

_____ **Kosten deelvervoer - mogelijke abonnementskosten** De prijs van mogelijke abonnementskosten voor gebruik van de deelvervoer service. (5)

_____ **Bereikbaarheid deelvervoer** De loop- of fietsafstand die u af moet leggen voor u gebruik kan maken van het deelvervoer. (6)

_____ **Aanbod deelvervoer** Het aanbod van verschillende voertuigen en transportmiddelen binnen de service. (7)

End of Block: Experience Shared Mobility

Start of Block: Stad-up

Intro: Stad-up is een deelmobiliteit-service van in Enschede, die op het moment gebruikt wordt gebruik door de Gemeente Enschede voor al het werkverkeer. De service werkt als volgt;

Afhankelijk van de afstand, de weeromstandigheden en de bereikbaarheid van de bestemming kan er gebruik worden gemaakt van elektrische deelfietsen, OV-vervoer of elektrische deelauto's. Zie de afbeelding hieronder voor hoe dit precies in zijn werk gaat.

Door middel van een app is het mogelijk om de deelfietsen en deelauto's te reserveren die zich bevinden in de Irene Garage, het Stadskantoor en de H.G. van Heek Garage. De app vertelt je waar en welke voertuigen beschikbaar zijn en met deze zelfde app kan je de voertuigen op open en afsluiten.

Je reserveert het voertuig dat je nodig hebt voor de tijdsperiode die je nodig hebt en na afloop plaats je deze weer terug op de zelfde locatie waar je hem vandaan hebt gehaald zodat een volgende werknemer hier weer gebruik van kan maken.

Door het gebruik dit deelmobiliteit-systeem wordt bijgedragen aan minder verkeersdrukte, schonere lucht, minder parkeeroverlast en gezondere werknemers door meer beweging.
Meer informatie vindt u op: https://stad-up.nl/

Page Break

Q36 **Als Stad-up beschikbaar wordt voor particulier gebruik, zou u dan gebruik maken van deze service?**

- Ja (1)
- Nee (2)

Q53 **Welke aspecten van Stad-up vindt u aantrekkelijk/interessant?**

_____

Display This Question:

If Als Stad-up beschikbaar wordt voor particulier gebruik, zou u dan gebruik maken van deze service? = Ja

Q37 **Hoe spreken de verschillende onderdelen van Stad-up u aan?**

	Zeer oninteressant (1)	Oninteressant (2)	Interessant (3)	Zeer interessant (4)
De elektrische fietsen (1)	•	•	•	•
Het Openbaar Vervoer abonnement (2)	•	•	•	•
De elektrische deelauto's (3)	•	•	•	•

Display This Question:

If Als Stad-up beschikbaar wordt voor particulier gebruik, zou u dan gebruik maken van deze service? = Ja

Q38 **Wat zouden voor u redenen zijn om gebruik te maken van Stad-up?**

_____

Display This Question:

If Als Stad-up beschikbaar wordt voor particulier gebruik, zou u dan gebruik maken van deze service? = Nee

Q39 **Wat zouden voor u redenen zijn om geen gebruik te maken van Stad-up?**

_____

Display This Question:

If Als Stad-up beschikbaar wordt voor particulier gebruik, zou u dan gebruik maken van deze service? = Nee

Q40 **Wat zou er moeten veranderen zodat u wel gebruik zou willen maken van Stad-up?**

_____

_____

Q42 **Bent u bekend van de onderstaande services die vergelijkbare services binnen Enschede aanbieden?**

(vink alle opties aan die voor u bekend zijn)

- ☐ GoSharing (1)
- ☐ GoAbout (2)
- ☐ SnappCar (3)
- ☐ GreenWheels (4)

End of Block: Stad-up

Start of Block: Personal Data

Tot slot willen we u vragen om enkele vragen te beantwoorden die met u als persoon te maken hebben. Deze vragen zijn zo algemeen dat uit de antwoorden nooit de persoon kan worden afgeleid.

Q21 **Wat is de postcode van uw woonadres?**
Het gaat hierbij alleen om de 4 cijfers van uw postcode

_____

Q22 **Wat is uw geslacht?**

- Vrouw (1)
- Man (2)
- Anders (3)

Q23 **Wat is uw leeftijd?**

- Jonger dan 25 jaar (1)
- 25 - 45 jaar (2)
- 46 - 65 jaar (3)
- Ouder dan 65 jaar (4)

Q25 **Welke van het volgende beschrijft uw huidige werksituatie het beste?**

- Werkeloos, op zoek naar werk (1)
- Werkeloos, niet op zoek naar werk (2)
- Werkzaam bij of in de buurt van het minimumloon (3)
- Part-time werkzaam (4)
- Full-time werkzaam (5)
- Gepensioeneerd (6)
- Anders, namelijk.. (7) _____

Q24 **Wat is uw hoogst behaalde opleidingsniveau?**

- Geen opleiding/onvolledig basisonderwijs (1)
- Basisschool (2)
- Middelbaar (3)
- Hoger beroepsonderwijs of technische hbo-opleiding (4)
- Universitair bachelor diploma (5)
- Universitair master diploma (6)
- Universitair gespecialiseerd diploma (doctoraal, juridisch) (7)
- Anders, namelijk.. (8) _____

End of Block: Personal Data

Appendix E

Interview Guide for Current Users

INTRODUCTION STRUCTURE OF THE INTRODUCTION OF THE INTERVIEW	
INTRO	*Hi, let me introduce myself.* *My name is Jade Frieling, I am a student at the University of Twente and I will be conducting this interview today .* [Propose Mel] *Before that, we will first explain a few things first, so let's get started.* *First of all, thank you for participating in this interview and research. You should have received our information email in advance. Is that right? Do you have any questions about this?*
TASKS	*As I said, I will conduct this interview with you. Mel will be taking notes throughout this interview.*
INFORMED CONSENT	*This information e-mail also contained our consent declarations, which I will briefly review with you so that I am sure that this has been received correctly.* [Quickly go through declarations of consent]
EARLY LEAVE	*I would also like to mention again that if you decide not to continue during the interview, you can indicate this at any time. We will then stop the interview.*
RECORD	*Okay , then I would now like to start recording this conversation. Are you satisfied with your background or do you have any questions about this?* [Start recording conversation]
AIM OF THE RESEARCH	*This interview is part of a study into the motivating factors for the use of Shared Mobility, aimed at the use of the Stad-up transport platform. To this end, we distributed various surveys among current users and residents of the city of Enschede. With this we map out the requirements and wishes of the current users and residents of Enschede.* *Your answers during this interview contribute to the development and expansion of this Stad-up service. We are looking for the underlying reasons and we will mainly ask the reasons why?*
SUBJECTS	During the interview we will discuss the following topics: 1. Your experiences with the use of Stad-up 2. City-up for private use

(Continued)

MAIN INTERVIEW

STRUCTURE OF THE MAIN INTERVIEW. VARIABLES, TOPICS, CENTRAL QUESTIONS AND SUB QUESTIONS.

WARM UPS	*Can you introduce yourself?* *How often have you used Stad-up?* *What do you use Stad-up for?*
USER EXPERIENCE 1. Explaining City-up 2. Questions feelings City-up › General › Reflection › Experience related to work › Information, instructions and support <u>Necessities</u> - Flow chart or City-u p - Pictures of the information on location, the information on the use flow (the pamphlet / manual they got)	**1. Explaining City-up** *Can you explain to me what exactly is according to your City-up? '* [Show flow chart or City-up] Discuss possible differences on the basis of answer. **2. Questions feelin g s City-up Example questions for the different topics.** General - *How often have you used the City-up service?* - *How do you experience the use of Stad-up?* - *What do you think of the City-up service?* - *Do you agree that the Municipality uses Stad-up?* - *How user-friendly do you think Stad-up is?* Reflection - *What could be better about Stad-up?* - *What's good about City-up?* - *What could be better?* Experience related to work - *Does Stad-up work well during your working days?* - *Does your City-up see an obstacle or an enrichment?* - *How do you experience Stad-up compared to the system for this?* Information, instructions and support - *What do you think of the information provided by Stad-up?* - *Do you know where to find information about Stad-up?* - *Do you find the service clear to use?* - *Which form of information do you find most clear (reading, youtube etc).* - *What sources of information do you use?* - *Have you become confused before, during or after using the car? How? If so, how was this problem solved? How did you feel during this problem? Why?*
CITY-UP FOR PRIVATE U SE <u>Necessities</u> - Some possible usage scenarios for Stad-up (how do they see themselves) - Different aspects of City-up visualizes	- *How do you feel about expanding Stad-up for private use ?* - *Could you use Stad-up for private use?* - *Which aspects of Stad-up would you like to use?* - *What should change about the service to use it for yourself?* - *What would you pay for this service?* - *What kind of scenarios could City-up be an addition to for you?*

(Continued)

CLOSE INTERVIEW STRUCTURE OF THE MAIN INTERVIEW. VARIABLES, TOPICS, CENTRAL QUESTIONS AND SUB QUESTIONS.	
CLOSING INTERVIEW	*Do you want to add anything to this conversation?* *Are there things that were not covered during this interview, but that you would have liked to share?* *What did you think of the interview?*
RECORDING	*Then I now close our recording.* [close recording]
MEMBER CHECKING	*After this interview, we will work out the interview. If you wish, you can receive a printout of this. Would you like that?*
THANKING	*Finally, I would like to thank you very much for your participation.*
POSSIBLE QUESTIONS	*If you have any questions, you can contact us via our e-mail address, from here you have also received the information e-mail.*

Appendix F

Pre-interview questionnaire for collection of basic personal information (for potential users/citizens):

Beste deelnemer,

Dank u wel voor uw deelname aan dit interview. Om het interview zo goed mogelijk te kunnen voorbereiden en gerichte vragen te kunnen stellen willen we u vragen om op voorhand deze korte vragenlijst in te vullen. Dit zal niet langer dan 5 minuten in beslag nemen.

Achtergrond informatie

- Naam
- Leeftijd
- Woonplaats
- Hoe groot is uw huishouden
- Hoeveel mensen bezitten een rijbewijs binnen uw huishouden

Relatie met mobiliteit

- Hoeveel personenauto's heeft u in bezit
- Hoe belangrijk is uw auto voor uw dagelijkse verplaatsingen
- Beschikt u over een elektrische auto?
- Welke vervoersmiddelen heeft u naast u persoonsauto in bezit?
- Van welke vervoersmiddelen maakt u het meest gebruik?
- Maakt u wel eens gebruik van het openbaar vervoer
- Heeft u een OV abonnement?
- Heeft u wel eens gebruik gemaakt van een gedeeld auto platform?

Interview Guide for Potential Users:

INTRODUCTION STRUCTURE OF THE INTRODUCTION OF THE INTERVIEW	
INTRO	*Hallo, ik zal me even voorstellen.* *Mijn naam is Jade Frieling, ik ben student aan de Universiteit Twente en ik zal vandaag dit interview afnemen.* [Voorstellen Mel] *Daarvoor gaan we eerst even daarvoor ga ik eerst het 1 en ander uitleggen, dus laten we beginnen.* *Als eerste dank u wel voor uw deelname aan dit interview en onderzoek. Als het goed is heeft u van te voren onze informatiemail ontvangen. Klopt dat? Heeft u hier nog vragen over?*
TASKS	*Zoals ik al zei zal ik dit interview bij u afnemen. Mel zal gedurende dit interview aantekeningen maken.*
INFORMED CONSENT	*In deze informatiemail stonden ook onze instemmingsverklaringen, deze loop ik nog even kort met u door zodat ik zeker weet dat dit goed overgekomen is.* [Snel doornemen instemmingsverklaringen]

EARLY LEAVE	*Ook wil ik nogmaals benoemen dat als uw tijdens het interview besluit niet meer verder te willen gaan, dan kun u dit ten alle tijden aangegeven. Wij zullen dan stoppen met het interview.*
RECORD	*Oke, dan wil ik nu graag beginnen met het opnemen van dit gesprek. Bent u tevreden met uw achtergrond of heeft u nog vragen hierover?* [Start opname gesprek]
AIM OF THE RESEARCH	*Dit interview is onderdeel van een onderzoek naar de motiverende factoren voor het gebruik van Shared Mobility, gericht op het gebruik van het vervoersplatform Stad-up. Hiervoor hebben we verschillende enquêtes verspreid onder de huidige gebruikers en de inwoners van de stad Enschede. Hiermee brengen we de eisen en wensen van de huidige gebruikers en bewoners van Enschede in kaart.* *Met uw antwoorden tijdens dit interview dragen bij aan het ontwikkelen en uitbreiden van deze Stad-up service. Hierbij zijn we opzoek naar de achterliggende redenen en zullen we vooral doorvragen op de redenen waarom?*
SUBJECTS	Tijdens het interview gaan we in op de volgende onderwerpen: 1. Uw ervaringen met deelmobiliteit 2. Het deelvervoer platform Stad-up

MAIN INTERVIEW

STRUCTURE OF THE MAIN INTERVIEW. VARIABLES, TOPICS, CENTRAL QUESTIONS AND SUB QUESTIONS.

WARM-UPS	Kort bespreken op voorhand ingevulde vragenlijstje. *Ik zie dat uw x aantal auto's heeft, vind u dat genoeg?* *Bent u tevreden met uw vervoersopties?* *Denkt u in de toekomst aan het kopen van een tweede auto?*
EXPERIENCE SHARED MOBILITY **1. Warm-ups** **2. Questions Shared Mobility** › General feeling about Shared Mobility › Reasons to have/choose Shared Mobility **3. Different aspects Shared Mobility** **Necessities**	**1. Warm-ups** *Bent u bekend met deelmobiliteit?* *Weet u welke deelplatformen er allemaal zijn in Enschede?* **2. Questions Shared Mobility** **General feeling about Shared Mobility** - Wat vind u van deelmobiliteit? Waarom? - *Is deelmobiliteit iets wat u toe zou kunnen voegen aan uw dagelijkse leven ?* **Reasons to have/choose Shared Mobility** Used shared mobility before: - *Waarom heeft u gebruik gemaakt van deelmobiliteit?* - *In wat voor scenario heeft u gebruik gemaakt van deelmobiliteit?*

- Visualization different aspects Shared mobility	- *Speelt duurzaamheid / de impact van uw auto ook een rol bij deze keuze?* Never sed shared mobility before: - *Waarom heeft u nooit gebruik gemaakt van deelmobiliteit?* - *Zou u wel gebruik willen maken van deelmobiliteit?*
	3. Different aspects Shared Mobility
	[weergeven verschillende aspecten deelmobiliteit] *Welke onderdelen hiervan zijn belangrijk voor u en waarom?*
THE STAD-UP CASE **1. Explaining Stad-up** **2. Questions Stad-up** › Impression and General feeling › Motivation, Acceptance, Adaptation, Resistance factors **Necessities**	**1. Explaining Stad-up**
	Uitleg Stad-up aan de hand van Visuals en foto's.
	2. Questions Stad-up
	Impression and General feeling - *Wat vindt u van het Stad-up deelvervoersplatform?* - *Zou u gebruik gaan maken van Stad-up?* - *Zou Stad-up een verrijking voor u vervoersmogelijkheden kunnen zijn?* - *Zijn er dingen waarvan u meteen zegt dat is heel handig of juist dat is absoluut onhandig.* **Motivation, Acceptance, Adaptation, Resistance factors**

- Quick explanation of Stad-up + pictures - Different aspects of Stad-up - Examples different payment systems - Possible use scenario's	Would use Stad-up: - *Welke onderdelen van Stad-up zou u gebruik van maken (auto's, fietsen, OV kaart)? Waarom?* - *Voor wat voor soort scenario's zou je gebruik kunnen maken van Stad-up?* - *Wat zou je betalen voor zo'n service?* - *Wat voor betalingsysteem zou je het liefst hebben?* Wouldn't use Stad-up: - *Wat zou er moeten veranderen aan Stad-up om er wel gebruik van te maken?*

CLOSE INTERVIEW

STRUCTURE OF THE MAIN INTERVIEW. VARIABLES, TOPICS, CENTRAL QUESTIONS AND SUB QUESTIONS.

CLOSING INTERVIEW	*Wilt u nog iets toevoegen aan dit gesprek?* *Zijn er dingen die niet aan bod zijn gekomen tijdens dit interview, maar die u wel graag had willen vertellen?* *Wat vond u van het interview?*
RECORDING	*Dan sluit ik nu onze opname af.* [afsluiten opname]
MEMBERCHECKING	*Na afloop van dit interview, zullen wij het interview uitwerken. Als u wilt kunt u hier een uitdraai van ontvangen. Zou u dat willen?*

THANKING	*Dan wil ik u als laatste heel hartelijk bedanken voor uw deelname.*
POSSIBLE QUESTIONS	*Mocht u nog vragen hebben dan kunt u contact met ons opnemen via ons mailadres, vanuit hier heeft u ook de informatiemail ontvangen.*

Appendix G

Survey Configuration and Data Analysis Scheme (for Current Users)

Survey Configuration and Data Analysis Scheme

Research Questions

- Q1: What factors raise or reduce (motivation and resistance) acceptance, trustworthiness and adoption of the service? What are the enablers and barriers for people adopting the service?
  - o How are these factors affected by **individual differences (psychographic and behavioral factors)** in terms of *life style, values, believes, demand, expenses for mobility etc.* ?
  - o How are these factors affected by demographic differences in terms of profession, age, ownership of cars etc.?
  - o How are these factors affected by other factrs
- Q2: What is the current user experience of the Stadup service?
  - o What is good about it?
  - o What is bad about it? What are users' (main) pain points?
  - o What needs to be changed in Stadup?
- Q3: What do users (think they) need? What do they expect?

Data cleaning

Filter	Action
Completion time	Pick out the fast respondents and screen them individually to decide whether to discard (100s)
User selection criteria	live in Enschede

Exploratory and Confirmatory Analysis

Factor	Question num	Variable name	Explanation	Question Type	Method	
Basic attributes and Background of Ps	Q7	gender	gender	Demographic	Descriptive (frequency)	As a grouping factor (use a crosstab)
	Q6	age	age	Demographic	Descriptive: (1) Frequency (2) Plot	- As grouping factor in ANOVA or Chisq test - As predictor (in Regression)
	Q8	zip	area/distance from city center (zip code)	Geographic	Descriptive (frequency)	
	Q9	edu	education level	Demographic	Descriptive: (1) Frequency (2) Plot	
	Q3.1	NUM_CAR	number of owned cars	Demographic	Descriptive: frequency&plot Recode ccategorical variable / recode the levels	- As grouping factor in ANOVA or Chisq test - As predictor (in Regression)
	Q3.2	NUM_DL	Num of driving licenses	/	No Use	
	Q1	HS	household size	Demographic	Descriptive: (1) Frequency (2) Plot	- As grouping factor in ANOVA or Chisq test - As predictor (in Regression)
	Q4	ECAR_EXP	experience with electric car	Bahavior	Descriptive: (1) Frequency (2) Plot	- As grouping factor in ANOVA or Chisq test - As predictor (in Regression)
	Q57	SM_EXP	experience with shared mobility	Bahavior	Descriptive: (1) Frequency (2) Plot	- As grouping factor in ANOVA or Chisq test - As predictor (in Regression)
Before using Stad-up	Q13	BFU_FEEL	feel about not using private car bc. Stadup	Feeling	Descriptive (frequency;3-point)	-
	Q15	BFU_EXP	looked forward to Stadup ?	Feeling	Descriptive (frequency;3-point)	-
	Q14_1	BFA_1	before-use attitude_1 Obstructive- Supportive	Attitude	Descriptive: (1) Generate an average score out of all 8 items -> new variable "Before-use perceived usabiltiy of Stadup"	- As predictor (in Regression) - As Outcome variable
	Q14_2	BFA_2	before-use attitude_2 Complex- Simple			
	Q14_3	BFA_3	before-use attitude_3 Inefficient- Efficient			
	Q14_4	BFA_4	before-use attitude_4 Confusing- Clear			
	Q14_5	BFA_5	before-use attitude_5 Annoying- Exciting			
	Q14_6	BFA_6	before-use attitude_6 Uninteresting- Interesting			
	Q14_7	BFA_7	before-use attitude_7 Everyday- Original			
	Q14_8	BFA_8	before-use attitude_8 Old-fashioned- New			

(Continued)

Usage of Stadup	Q21	SU_USAGE	Usage of Stadup - whether ever used it or not	Behavior	Descriptive (frequency)	Descriptive analysis
	Q17	?	used which transport	Behavior		
	Q50	/	why NOT use Stadup_choice	Pain point; Need	Descriptive (frequency)	
	Q50_6_TEXT	/	why NOT use Stadup_text		-	
	Q51	/	why NOT comfortable about SU	Pain point	Descriptive (frequency)	
	Q52	/	what is NOT clear	Pain point		
	Q54	/	what to change in SU?	Thought & Expectation		
	Q22_1	FRE_BIKE	frequency of use_ebike	Behavior	Descriptive (frequency)	
	Q22_2	FRE_NS	frequency of use_NS Businesscard			
	Q22_3	FRE_CAR	frequency of use_ecars			
	Q50		why NOT used ecars_choice	Pain point; Need	Descriptive (frequency)	
	Q50_6_TEXT	/	why NOT used ecars_text		Text	
Experience evaluation of SU_A	Q49_1	EVAL_SU_1	After-use perceived usability of SU Obstructive- Supportive	Feeling/Experience	Descriptive: (1) Average score out of all 8 items to make a new variable "After-use perceived usabiltiy of Stadup"	- As predictor (in Regression) '- As Outcome variable
	Q49_2	EVAL_SU_2	After-use perceived usability of SU Complex- Simple			
	Q49_3	EVAL_SU_3	After-use perceived usability of SU Inefficient- Efficient			
	Q49_4	EVAL_SU_4	After-use perceived usability of SU Confusing- Clear			
	Q49_5	EVAL_SU_5	After-use perceived usability of SU Annoying- Exciting			
	Q49_6	EVAL_SU_6	After-use perceived usability of SU Uninteresting- Interesting			
	Q49_7	EVAL_SU_7	After-use perceived usability of SU Everyday- Original			
	Q49_8	EVAL_SU_8	After-use perceived usability of SU Old-fashioned- New			
	Q24_1	/	Resources_bike- What could have been better?	Pain point/Need	Text	Text analysis? Key word extraction, categorize into groups (e.g., affinity map)
	Q24_2	/	Resources_bike What could be better?	Thought & Expectation		
	Q24_3	/	Resources_bike What is good?	Thought		
	Q42_1	/	Resources_ NS Businesscard What could have been better?	Pain point/Need		
	Q42_2	/	Resources_NS Businesscard What could be better?	Thought & Expectation		
	Q42_3	/	Resources_NS Businesscard What is good?	Thought		
	Q47	/	Knew NS card was part of Stadup or not	Behavior		-
	Q43_1	/	Resources_ecar What could have been better?	Pain point/Need		Text analysis? Key word extraction, categorize into groups (e.g., affinity map)
	Q43_2	/	Resources_ecar What could be better?	Thought & Expectation		
	Q43_3	/	Resources_ecar What is good?	Thought		
	Q56	EVAL_SU_APP	UX evaluation of **App**	Feeling/Experience	Descriptive	As predictor (in Regression)
Experience evaluation of SU_B	Q44_1	/	Operation_bike- What could have been better?	Pain point/Need	Text	Text analysis? Key word extraction, categorize into groups (e.g., affinity map)
	Q44_2	/	Operation_bike- What could be better?	Thought & Expectation		
	Q44_3	/	Operation_bike- What is good?	Thought		
	Q45_1	/	Operation_ NS Businesscard - What could have been better?	Pain point/Need		
	Q45_2	/	Operation_NS Businesscard - What could be better?	Thought & Expectation		
	Q45_3	/	Operation_NS Businesscard - What is good?	Thought		
	Q46_1	/	Operation_ecar-What could have been better?	Pain point/Need		
	Q46_2	/	Operation_ecar-What could be better?	Thought & Expectation		
	Q46_3	/	Operation_ecar-What is good?	Thought		

(Continued)

Motivation factors of adoption and their relative importance (for people with NO shared car experience)	Q31_1	AVA0	Rank_availability guarantee	Motivation	Descriptive: Ranks (transform to in percentage)	-
	Q31_2	PARK0	Rank_Parking options upon return			
	Q31_3	INSU0	Rank_Insurance & deductible			
	Q31_4	KILOC0	Rank_kilometer costs			
	Q31_5	SUBSC0	Rank_subscription costs			
	Q31_6	ACCESS0	Rank_Accessibility/walking diatance			
	Q31_7	OPT0	Rank_transport options/ variety			
Basic shared car usage	Q32	N_SCAR_USE	Total times of use shared car	Behavior	Descriptive: (1) Frequency/percentage (2) Plots	-
Motivation of using a shared car	Q33	/	Reason of using a shared car	Motivation	text	text analysis (key word and categorization)
Motivation factors of adoption and their relative importance (for people with shared car experience)	Q34_1	AVA1	Rank_availability guarantee	Motivation	Descriptive: Ranks (transform to in percentage)	-
	Q34_2	PARK1	Rank_Parking options upon return			
	Q34_3	INSU1	Rank_Insurance & deductible			
	Q34_4	KILOC1	Rank_kilometer costs			
	Q34_5	SUBSC1	Rank_subscription costs			
	Q34_6	ACCESS1	Rank_Accessibility/walking diatance			
	Q34_7	OPT1	Rank_transport options/ variety			
Acceptance and feeling about SU	Q36	INTENT_SU	Intention to use Stadup	Motivation/Intention	Descriptive: (1) Frequency/percentage (2) Plots	As Outcome variable in ANOVA/Chisq test/Regression
	Q53	/	Which aspect of SU most appleaing	Attitude/Feeling	text	-
	Q37_1	ATT_SU_BIKE	Attractiveness rating of each mode_ebike	Attitude/Feeling	Descriptive: (1) Frequency (2) Plots	-
	Q37_2	ATT_SU_TRAIN	Attractiveness rating of each mode_NS			
	Q37_3	ATT_SU_ECAR	Attractiveness rating of each mode_ecar			
Motivation of using SU	Q38	/	Reasons to want to use SU	Motivation	text	text analysis (key word and categorization)
Resistance to using SU	Q39	/	Reasons to NOT want to use SU	Motivation/Resistence		
	Q40	/	What should change ?	Thought/Pain point/Need	text	text analysis (key word and categorization)

Appendix H

Survey Configuration and Data Analysis Scheme (for Potential Users)

Survey Configuration and Data Analysis Scheme

Research Questions

- Q1: How are the different attributes and characteristics of users related to their responses towards Shared Mobility and Stad-up service?
  - o How are Geographics and Demographics factors related to user responses?
  - o How are Behavioral factors (e.g., knowledge or experience with Shared Mobility) related to user responses?
  - o How are Psychographic factors (e.g., personal value regarding spending) related to user responses?

- Q2: What factors raise or reduce (motivation and resistance factors) acceptance, trustworthiness and adoption of Shared Mobility? What are the enablers and barriers for people adopting the service?
  - o How are these factors affected by **individual differences (psychographic and behavioral factors)** in terms of *life style, values, believes, demand, expenses for mobility, existing attitude towards shared mobility etc.* ?
  - o How are these factors affected by **demographic differences** in terms of *profession, age, household size, ownership of cars* etc.?

- Q3: What do users think of Stadup and how do they think it would be relevant to them?
  - o How likely do they think they will adopt Stadup?
  - o What in Stadup attracts users? Which aspects in Stadup may be the most relevant to them?

Data cleaning

Filter	Explanation
Missing value	Fill it with Mean or use other strategies
Completion time	Pick out the fast respondents and screen them individually to decide whether to discard
User selection criteria	Age >= 18; live in Singel area of Enschede

Exploratory and Confirmatory Analysis

Factor	Question num	Variable name	Explanation	Question Type	Analysis approach	
Basic attributes and background information of Ps	Q4	HS	Household size	Demographic	Descriptive: (1) Frequency/Percentage (2) Plots	- As grouping factor in ANOVA and Chisq test - As predictor (in Regression)
	Q5	NUM_DL	Num of driving license	Mobility-specific		
	Q6	NUM_CAR	Num of cars owned	Mobility-specific		- As grouping factor in ANOVA and Chisq test - As predictor (in Regression)
	Q42	FAM_SM	Familiar to which transport service in Enschede	/		
	Q21	ZIP code	Zip code	Geographic		
	Q22	GENER	Gender	Demographic		- As grouping factor in ANOVA and Chisq test - As predictor (in Regression)
	Q23	AGE	Age	Demographic		- As grouping factor in ANOVA and Chisq test - As predictor (in Regression)
	Q25	WORK_STAT	work situation_choice	Demographic		- As grouping factor in ANOVA and Chisq test - As predictor (in Regression)
	Q25_7_TEXT	/	Work status_text			
	Q24	EDU	Highest education_choice	Demographic		
	Q24_8_TEXT	/	Highest education_text			
	Q8	ECAR	Ownership of Electric car	Demographic		
	Q9	ECAR_EXP	Electric car experience	Demographic/Experience		- As grouping factor in ANOVA and Chisq test - As predictor (in Regression)
	Q26	SCAR_EXP	Shared car experience	Demographic/Experience		- As grouping factor in ANOVA and Chisq test - As predictor (in Regression)
	Q11	TSP_OWNED	Other transport type owned_choice		Descriptive: (1)Frequency/percentage (2) Plots	-
	Q11_6_TEXT	/	Other transport type owned_text			

(Continued)

Car-related expense	Q10	KNOW_CARCOST	Know annual cost of keeping a car?_choice	Behavior	Descriptive	
	Q10_2_TEXT		Know annual cost of keeping a car?_text			
Value about general consumption and the car	Q50	PERC_CARCOST	Percentage of car-related cost in annual income		Descriptive	-
	Q50_2_TEXT		Percentage of car-related cost in annual income			
	Q46	GEN_VALUE_1	Value_product sustainability	Value (general)	Descriptive: (1) Frequency/percentage (2) Plots	-As predictor (in Regression)
	Q47	GEN_VALUE_2	Value_save costs			
	Q49	CAR_VALUE_1	Value_functionality of a car is important	Value (car) : functionality and Symbolism (reverse of Functionality)	Descriptive: (1) Frequency (2) Plots	
	Q52	CAR_VALUE_2	Value_car as a reflection of self identity		Reverse-score Q52; Combine into a variable "Functionality value of car"	
	Q7	CAR_VALUE_DT	Perceived importance of car to daily transprt (=Dependency on car)		Descriptive	
Basic situation of other everyday transport	Q13	TSP_USE	Most used transport_choice	Behavior	Descriptive: (1) Frequency/percentage (2) Plots	
	Q13_7_TEXT		Most used transport_text			
	Q15	PUB_TSP	Usage public transport (use vs no use)			- As grouping factor in ANOVA and Chisq test - As predictor (in Regression)
	Q12	PUB_TSP_SUB	Have a public transport subscription?			
	Q17	PUB_TSP_FREQ	How often use public transport?			
	Q16	PUB_TSP_USE	Used Public transport mode_choice			
	Q16_6_TEXT	/	Used Public transport mode_text			
Evaluation and attitude towards current public transport	Q18_1	P_TSP_EVAL1	Evaluation of current public transport Extensive- Limited	Attitude	Descriptive: Average all items to make an overall score -> to check its relations to each grouping factors	
	Q18_2	P_TSP_EVAL2	Evaluation of current public transport Obstructive- Supportive			
	Q18_3	P_TSP_EVAL3	Evaluation of current public transport Complex- Simple			
	Q18_4	P_TSP_EVAL4	Evaluation of current public transport Inefficient- Efficient			
	Q18_5	P_TSP_EVAL5	Evaluation of current public transport Confusing- Clear			
	Q18_6	P_TSP_EVAL6	Evaluation of current public transport Old-fashioned- Innovative			
	Q19	C_TSP_SAT	Satisfaction with current transport		Descriptive: (1) Frequency/percentage (2) Plots	As predictor (in Regression)
Attitude towards Shared car and existing adoption intention	Q27	ATT_SCAR	Attitude to shared car	Attitude	Descriptive: (1) Frequency/percentage (2) Plots	As Outcome variable in ANOVA/Chisq test/Regression
	Q28	INT_SCAR1	Thought about using a shared car?	Motivation/Intention	Descriptive	
	Q29	INT_SCAR2	Intention to use shared car	Motivation/Intention	Descriptive: (1) Frequency/percentage (2) Plots	As Outcome variable in ANOVA/Chisq test/Regression
Motivation factors of adoption and their relative importance (for people with NO shared car experience)	Q31_1	AVA0	Rank_availability guarantee	Motivation	Descriptive: Ranks (transform to in percentage)	-
	Q31_2	PARK0	Rank_Parking options upon return			
	Q31_3	INSU0	Rank_Insurance & deductible			
	Q31_4	KILOC0	Rank_kilometer costs			
	Q31_5	SUBSC0	Rank_subscription costs			
	Q31_6	ACCESS0	Rank_Accessibility/walking diatance			
	Q31_7	OPT0	Rank_transport options/ variety			

(Continued)

Motivation factors of adoption and their relative importance (for people with NO shared car experience)	Q31_1	AVA0	Rank_availability guarantee	Motivation	Descriptive: Ranks (transform to in percentage)	-
	Q31_2	PARK0	Rank_Parking options upon return			
	Q31_3	INSU0	Rank_Insurance & deductible			
	Q31_4	KILOC0	Rank_kilometer costs			
	Q31_5	SUBSC0	Rank_subscription costs			
	Q31_6	ACCESS0	Rank_Accessibility/walking diatance			
	Q31_7	OPT0	Rank_transport options/ variety			
Basic shared car usage	Q32	N_SCAR_USE	Total times of use shared car	Behavior	Descriptive: (1) Frequency/percentage (2) Plots	-
Motivation of using a shared car	Q33	/	Reason of using a shared car	Motivation	text	text analysis (key word and categorization)
Motivation factors of adoption and their relative importance (for people with shared car experience)	Q34_1	AVA1	Rank_availability guarantee	Motivation	Descriptive: Ranks (transform to in percentage)	-
	Q34_2	PARK1	Rank_Parking options upon return			
	Q34_3	INSU1	Rank_Insurance & deductible			
	Q34_4	KILOC1	Rank_kilometer costs			
	Q34_5	SUBSC1	Rank_subscription costs			
	Q34_6	ACCESS1	Rank_Accessibility/walking diatance			
	Q34_7	OPT1	Rank_transport options/ variety			
Acceptance and feeling about SU	Q36	INTENT_SU	Intention to use Stadup	Motivation/Intention	Descriptive: (1) Frequency/percentage (2) Plots	As Outcome variable in ANOVA/Chisq test/Regression
	Q53	/	Which aspect of SU most appleaing	Attitude/Feeling	text	-
	Q37_1	ATT_SU_BIKE	Attractiveness rating of each mode_ebike	Attitude/Feeling	Descriptive: (1) Frequency (2) Plots	-
	Q37_2	ATT_SU_TRAIN	Attractiveness rating of each mode_NS			
	Q37_3	ATT_SU_ECAR	Attractiveness rating of each mode_ecar			
Motivation of using SU	Q38	/	Reasons to want to use SU	Motivation	text	text analysis (key word and categorization)
Resistance to using SU	Q39	/	Reasons to NOT want to use SU	Motivation/Resistence		
	Q40	/	What should change ?	Thought/Pain point/Need	text	text analysis (key word and categorization)

Appendix I

R codes for Current User Survey Data Analysis

```
library(knitr)
#install.packages("weatherData",repos = "http://cran.us.r-project.org")
library(tidyverse)
```

```
## ── Attaching packages ─────────────────────────────────────── tidyverse
1.3.0 ──
```

```
## ✓ ggplot2 3.3.3     ✓ purrr   0.3.4
## ✓ tibble  3.0.4     ✓ dplyr   1.0.2
## ✓ tidyr   1.1.2     ✓ stringr 1.4.0
## ✓ readr   1.4.0     ✓ forcats 0.5.0
```

```
## ── Conflicts ────────────────────────────────────────
tidyverse_conflicts() ──
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(readxl)
library(ggplot2)

#install.packages("rstanarm")
library(rstanarm)
```

```
## Loading required package: Rcpp
```

```
## This is rstanarm version 2.21.1
```

```
## - See https://mc-stan.org/rstanarm/articles/priors for changes to
default priors!
```

```
## - Default priors may change, so it's safest to specify priors, even if
equivalent to the defaults.
```

```
## - For execution on a local, multicore CPU with excess RAM we recommend
calling
```

```
##   options(mc.cores = parallel::detectCores())
```

```
#library(gridExtra)

options(mc.cores = 4)
```

Import my Excel data (Employee survey)

```
D <- read_xlsx("Employee_data_0304.xlsx")
```

Data summary

```
sm <- summary(D)
sm
```

```
##     Progress        Duration          gender              age
##  Min.   :  4.0   Min.   :   108.0   Length:112         Length:112
##  1st Qu.:100.0   1st Qu.:   429.5   Class :character   Class :character
##  Median :100.0   Median :   680.5   Mode  :character   Mode  :character
```

```
##  Mean   : 88.4   Mean   :  4903.9
##  3rd Qu.:100.0   3rd Qu.:  1182.0
##  Max.   :100.0   Max.   :404458.0
##
##       zip           edu                HS               NUM_DL
##  Min.   :4859   Length:112         Length:112         Length:112
##  1st Qu.:7514   Class :character   Class :character   Class :character
##  Median :7541   Mode  :character   Mode  :character   Mode  :character
##  Mean   :7500
##  3rd Qu.:7559
##  Max.   :7742
##  NA's   :23
##    NUM_CAR             ECAR             ECAR_EXP           SM_EXP
##  Length:112         Length:112         Length:112         Length:112
##  Class :character   Class :character   Class :character
Class :character
##  Mode  :character   Mode  :character   Mode  :character
Mode  :character
##
##
##
##
##    BFU_FEEL           BFU_EXP              BFA_1           BFA_2
##  Length:112         Length:112         Min.   :1.000   Min.   :1.000
##  Class :character   Class :character   1st Qu.:2.000   1st Qu.:2.000
##  Mode  :character   Mode  :character   Median :3.000   Median :2.000
##                                        Mean   :2.829   Mean   :2.457
##                                        3rd Qu.:4.000   3rd Qu.:3.000
##                                        Max.   :5.000   Max.   :5.000
##                                        NA's   :7       NA's   :7
##      BFA_3           BFA_4           BFA_5           BFA_6           BFA_7
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
Min.   :1.00
##  1st Qu.:2.000   1st Qu.:2.000   1st Qu.:2.000   1st Qu.:3.000   1st
Qu.:3.00
##  Median :3.000   Median :3.000   Median :3.000   Median :3.000
Median :4.00
##  Mean   :2.581   Mean   :2.819   Mean   :2.943   Mean   :3.362
Mean   :3.59
##  3rd Qu.:3.000   3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:4.000   3rd
Qu.:4.00
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
Max.   :5.00
##  NA's   :7       NA's   :7       NA's   :7       NA's   :7       NA's   :7
##      BFA_8          BFA_AVG        SU_USAGE           FRE_BIKE
##  Min.   :1.000   Min.   :1.000   Length:112         Length:112
##  1st Qu.:3.000   1st Qu.:2.500   Class :character   Class :character
##  Median :4.000   Median :3.125   Mode  :character   Mode  :character
##  Mean   :3.962   Mean   :3.068
##  3rd Qu.:5.000   3rd Qu.:3.625
##  Max.   :5.000   Max.   :5.000
##  NA's   :7       NA's   :7
##     FRE_NS            FRE_CAR            EVAL_SU_1       EVAL_SU_2
##  Length:112         Length:112         Min.   :1.000   Min.   :1.000
```

```
##  Class :character   Class :character   1st Qu.:2.000   1st Qu.:2.000
##  Mode  :character   Mode  :character   Median :3.000   Median :3.000
##                                        Mean   :2.917   Mean   :3.036
##                                        3rd Qu.:4.000   3rd Qu.:4.000
##                                        Max.   :5.000   Max.   :5.000
##                                        NA's   :28      NA's   :28
##    EVAL_SU_3       EVAL_SU_4       EVAL_SU_5       EVAL_SU_6
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:1.000   1st Qu.:3.000   1st Qu.:2.000   1st Qu.:3.000
##  Median :3.000   Median :3.000   Median :3.000   Median :3.000
##  Mean   :2.845   Mean   :3.183   Mean   :2.929   Mean   :3.373
##  3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:4.000
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
##  NA's   :28      NA's   :30      NA's   :28      NA's   :29
##    EVAL_SU_7       EVAL_SU_8      EVAL_SU_AVG      NS_KNOW
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Length:112
##  1st Qu.:3.000   1st Qu.:3.000   1st Qu.:2.469   Class :character
##  Median :4.000   Median :4.000   Median :3.250   Mode  :character
##  Mean   :3.663   Mean   :3.855   Mean   :3.209
##  3rd Qu.:4.000   3rd Qu.:5.000   3rd Qu.:3.906
##  Max.   :5.000   Max.   :5.000   Max.   :5.000
##  NA's   :29      NA's   :29      NA's   :28
##  EVAL_SU_APP         HELPD_EXP         EVAL_HELPD            AVA
##  Length:112         Length:112         Length:112         Min.   :1.000
##  Class :character   Class :character   Class :character   1st Qu.:1.000
##  Mode  :character   Mode  :character   Mode  :character   Median :1.000
##                                                           Mean   :2.325
##                                                           3rd Qu.:3.500
##                                                           Max.   :7.000
##                                                           NA's   :29
##       PARK            INSU           KILOC           SUBSC          ACCESS
##  Min.   :1.000   Min.   :2.000   Min.   :1.000   Min.   :1.00
Min.   :1.000
##  1st Qu.:3.000   1st Qu.:5.000   1st Qu.:3.000   1st Qu.:3.00   1st
Qu.:2.000
##  Median :4.000   Median :6.000   Median :5.000   Median :5.00
Median :2.000
##  Mean   :4.494   Mean   :5.458   Mean   :4.398   Mean   :4.41
Mean   :2.807
##  3rd Qu.:6.000   3rd Qu.:7.000   3rd Qu.:6.000   3rd Qu.:6.00   3rd
Qu.:4.000
##  Max.   :7.000   Max.   :7.000   Max.   :7.000   Max.   :7.00
Max.   :7.000
##  NA's   :29      NA's   :29      NA's   :29      NA's   :29     NA's   :29
##       OPT         INTENT_SU
##  Min.   :1.000   Length:112
##  1st Qu.:3.000   Class :character
##  Median :4.000   Mode  :character
##  Mean   :4.108
##  3rd Qu.:6.000
##  Max.   :7.000
##  NA's   :29
```

Create a new variable: calculate Before-use evaluation (Before-use perceived usability) score: generated by averaging the scores for the eight before-use attitude dimensions

```
D$BFU_EVAL <- (D$BFA_1+D$BFA_2+D$BFA_3+D$BFA_4+D$BFA_5+
                D$BFA_6+D$BFA_7+D$BFA_8)/8
```

Create a new variable: calculate After-use Evaluation (After-use perceived usability) score (ATU_EVAL)

```
D$ATU_EVAL <-
(D$EVAL_SU_1+D$EVAL_SU_2+D$EVAL_SU_3+D$EVAL_SU_4+D$EVAL_SU_5+
                D$EVAL_SU_6+D$EVAL_SU_7+D$EVAL_SU_8)/8
```

Rankings of motivation factors BY Intention to use Stad-up (INTENT_SU: Ja / Nee)

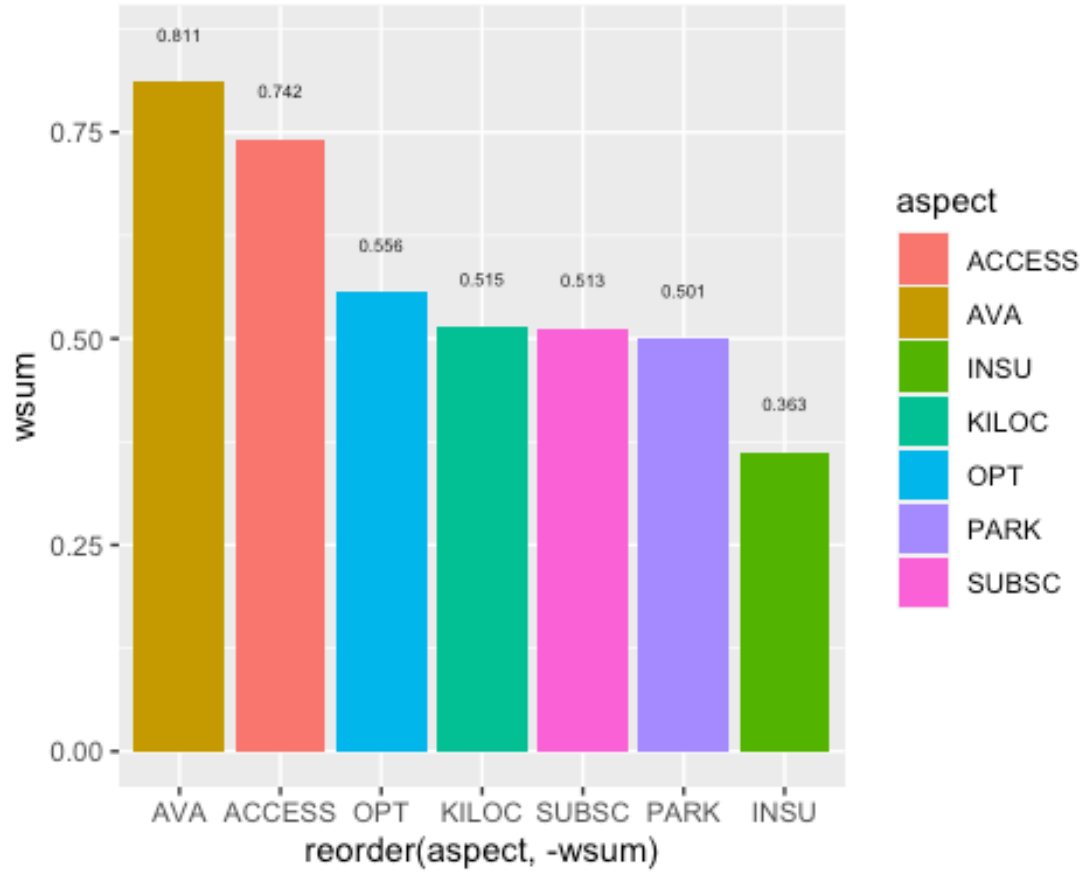
```
D2 <- D[,41:47]  #select the columns that correspond to motivation factors ranking

# Transforming values
D2[D2 == 1 ] <- 1
D2[D2 == 2 ] <- 6/7
D2[D2 == 3 ] <- 5/7
D2[D2 == 4 ] <- 4/7
D2[D2 == 5 ] <- 3/7
D2[D2 == 6 ] <- 2/7
D2[D2 == 7 ] <- 1/7

D2 %>%
   filter(D2 > 0) %>%
   gather(key = "aspect", value = "value") %>%
   group_by(aspect) %>%
   summarise(wsum = mean(value, na.rm = T)) %>%
   ggplot(aes(x = reorder(aspect,-wsum), y = wsum)) +
   geom_col(aes(fill = aspect), position="dodge") +
   geom_line(lty = 3) +
   geom_text(aes(label=wsum, y=wsum+0.05),
             position=position_dodge(0.9), size = 2, vjust=0)
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## geom_path: Each group consists of only one observation. Do you need to adjust
## the group aesthetic?
```



Conclusion: Availability and Accessibility are the most important to all people investigated, whether those that agree to or are NOT intending to adopt Stad-up for Private use in the future. Insurance is the least important factor to all of them.

Use the data to make charts in Excel

```
D2 %>%
   filter(D2 > 0) %>%
   gather(key = "aspect", value = "value") %>%
   group_by(aspect) %>%
   summarise(wsum = mean(value, na.rm = T))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## # A tibble: 7 x 2
##   aspect  wsum
##   <chr>  <dbl>
## 1 ACCESS 0.742
## 2 AVA    0.811
## 3 INSU   0.363
## 4 KILOC  0.515
## 5 OPT    0.556
## 6 PARK   0.501
## 7 SUBSC  0.513
```

Correlation between Before-use evaluation (BFU_EVAL) and After-use evaluation (ATU_EVAL)

```
corr <- cor.test(D$BFU_EVAL, D$ATU_EVAL, method=c("pearson"))
corr
```

```
##
##  Pearson's product-moment correlation
##
## data:  D$BFU_EVAL and D$ATU_EVAL
## t = 11.884, df = 80, p-value < 2.2e-16
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.7040464 0.8658622
## sample estimates:
##       cor
## 0.7989825
```

Result: significant correlation (as expected). Conclusion: the more positive Before-use evaluation of Stad-up is, the more positive After-use evaluation of Stad-up.

CrossTables and Chi tests

Choose variables of interest to make a CrossTable

(1) Investigate relation between Number of owned cars and Intention to use Stad-up (No / Yes)

```
D3 <- D

D3$recode_NUM_CAR = ifelse(D3$NUM_CAR <= 1, "<=1",">1")

mytable <- xtabs(~recode_NUM_CAR+INTENT_SU, data = D3)
ftable(mytable) # print table
```

```
##               INTENT_SU Ja Nee
## recode_NUM_CAR
## <=1                    25  33
## >1                      6  26
```

```
summary(mytable) # chi-square test of indepedence
```

```
## Call: xtabs(formula = ~recode_NUM_CAR + INTENT_SU, data = D3)
## Number of cases in table: 90
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 5.417, df = 1, p-value = 0.01995
```

Conclusion: the more cars a household have, the less willing they are to adopt Stad-up for private use in the future.

(2) Investigate relation between Electric-car experience (Yes / No) and Intention to use Stad-up (No / Yes)

```
#D2 <- D

#D2$recode_NUM_CAR = ifelse(D2$NUM_CAR <= 1, "<=1",">1")

mytable2 <- xtabs(~ECAR_EXP+INTENT_SU, data = D3)
ftable(mytable2) # print table
```

```
##          INTENT_SU Ja Nee
## ECAR_EXP
## Ja                 3  22
## Nee               28  37
```

```
summary(mytable2) # chi-square test of indepedence
```

```
## Call: xtabs(formula = ~ECAR_EXP + INTENT_SU, data = D3)
## Number of cases in table: 90
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 7.723, df = 1, p-value = 0.005454
```

Conclusion: (not sure whether this is correct) Those who already have electric car experience are relatively less willing to adopt Stad-up for private use in the future. (?)

(3) Investigate the relation between Shared-Mobiltiy experience (Yes / No) and Intention to use Stad-up (No / Yes)

```
#D2 <- D

#D2$recode_NUM_CAR = ifelse(D2$NUM_CAR <= 1, "<=1",">1")

mytable <- xtabs(~SM_EXP+INTENT_SU, data = D3)
ftable(mytable) # print table
```

```
##        INTENT_SU Ja Nee
## SM_EXP
## Ja                3   2
## Nee              28  57
```

```
summary(mytable) # chi-square test of indepedence
```

```
## Call: xtabs(formula = ~SM_EXP + INTENT_SU, data = D3)
## Number of cases in table: 90
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 1.5312, df = 1, p-value = 0.2159
##  Chi-squared approximation may be incorrect
```

Conclusion: too few observations of “Ja” for the variable of Shared Mobility Experience (SM_EXP). That is, too few people have shared mobiltiy experience). No reliable conclusions can be made here.

One-wsay ANOVAs

(1) DV = Before-use evaluation score; Grouping variable = Electric car experience

```
anova_result1 <- aov(BFU_EVAL ~ ECAR_EXP, data = D3)
summary(anova_result1)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## ECAR_EXP     1   1.79  1.7872   2.477  0.119
## Residuals   88  63.49  0.7215
## 22 observations deleted due to missingness
```

Result: non-significance

(2) DV = Before-use evaluation score; Grouping variable = Nnumber of cars owned

```
anova_result2 <- aov(BFU_EVAL ~ recode_NUM_CAR, data = D3)
summary(anova_result2)
```

```
##                Df Sum Sq Mean Sq F value Pr(>F)
## recode_NUM_CAR  1   0.95  0.9543   1.305  0.256
## Residuals      88  64.33  0.7310
## 22 observations deleted due to missingness
```

Result: non-significance

(3) DV = Before-use evaluation score; Grouping variable = Shared mobility experience

```
anova_result3 <- aov(BFU_EVAL ~ SM_EXP, data = D3)
summary(anova_result3)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## SM_EXP       1   0.00  0.0000       0  0.994
## Residuals   88  65.28  0.7418
## 22 observations deleted due to missingness
```

Result: non-significance

(4) DV = After-use evaluation score; Grouping variable = Electric car experience

```
anova_result4 <- aov(ATU_EVAL ~ ECAR_EXP, data = D3)
summary(anova_result4)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## ECAR_EXP     1   0.91  0.9108   0.908  0.344
## Residuals   75  75.26  1.0034
## 35 observations deleted due to missingness
```

Result: non-significance

(5) DV = After-use evaluation score; Grouping variable = Number of cars owned

```
anova_result5 <- aov(ATU_EVAL ~ recode_NUM_CAR, data = D3)
summary(anova_result5)
```

```
##                Df Sum Sq Mean Sq F value Pr(>F)
## recode_NUM_CAR  1   2.37   2.369   2.408  0.125
## Residuals      75  73.80   0.984
## 35 observations deleted due to missingness
```

Result: non-significance

#ANOVA: if there's between-group difference (Shared mobility experience) on Before-use evaluation score?

```
anova_result6 <- aov(BFU_EVAL ~ SM_EXP, data = D3)
summary(anova_result6)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## SM_EXP       1   0.00  0.0000       0  0.994
## Residuals   88  65.28  0.7418
## 22 observations deleted due to missingness
```

Result: non-significance

Recode some categorical variables

```
D3$EVAL_SU_APP <- recode(D3$EVAL_SU_APP, "1_Zeer negatief" = 1,
"2_Negatief" = 2, "3_Neutraal" = 3, "4_Positief" = 4, "5_Zeer positief" =
5)

D3$EVAL_HELPD <- recode(D3$EVAL_HELPD, "1_Zeer negatief" = 1, "2_Negatief"
= 2, "3_Neutraal" = 3, "4_Positief" = 4, "5_Zeer positief" = 5)
```

```
## Warning: Unreplaced values treated as NA as .x is not compatible.
Please specify
## replacements exhaustively or supply .default
```

Stepwise Regression

Load the packages

```
#library(tidyverse) #already exist
#library(caret) #already exist

library(leaps)  #leaps() performs an exhaustive search for the best
subsets of the variables in x for predicting y in linear regression
```

##Model1 (After-use evaluation of Stad-up) ##Dependent variable = After-use evaluation of Stad-up ##Predictors: Before-use perceived usability, number of owned cars, electric car experience, and evaluation of App. ##Stepwise regression

```
D_model1 <- D3[c(11, 38, 49, 50, 51)]

#nvmax = maximum number of predictor variables;
```

```
#= leapSeq - stepwise; ~ = leapBackward; ~ = leapForward
model_ATU_EVAL <- regsubsets(ATU_EVAL~., data = D_model1, nvmax = 4,
                  = "seqrep")
summary(model_ATU_EVAL)
```

```
## Subset selection object
## Call: regsubsets.formula(ATU_EVAL ~ ., data = D_model1, nvmax = 4,
##     = "seqrep")
## 4 Variables  (and intercept)
##                 Forced in Forced out
## ECAR_EXPNee          FALSE      FALSE
## EVAL_SU_APP          FALSE      FALSE
## BFU_EVAL             FALSE      FALSE
## recode_NUM_CAR>1     FALSE      FALSE
## 1 subsets of each size up to 4
## Selection Algorithm: 'sequential replacement'
##          ECAR_EXPNee EVAL_SU_APP BFU_EVAL recode_NUM_CAR>1
## 1  ( 1 ) " "         " "         "*"      " "
## 2  ( 1 ) " "         "*"         "*"      " "
## 3  ( 1 ) "*"         "*"         "*"      " "
## 4  ( 1 ) "*"         "*"         "*"      "*"
```

Regression (to get coefficient estimates)

```
M_1a <- lm(ATU_EVAL ~ BFU_EVAL + recode_NUM_CAR + EVAL_SU_APP + ECAR_EXP,
          data = D_model1)

summary(M_1a)
```

```
##
## Call:
## lm(formula = ATU_EVAL ~ BFU_EVAL + recode_NUM_CAR + EVAL_SU_APP +
##     ECAR_EXP, data = D_model1)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.06272 -0.32470 -0.01736  0.33405  1.68115
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)      -0.08323    0.31030  -0.268    0.790
## BFU_EVAL          0.66258    0.09631   6.880 1.02e-08 ***
## recode_NUM_CAR>1 -0.11581    0.16651  -0.696    0.490
## EVAL_SU_APP       0.41624    0.08094   5.142 4.74e-06 ***
## ECAR_EXPNee       0.19496    0.17278   1.128    0.265
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.5654 on 49 degrees of freedom
##   (58 observations deleted due to missingness)
## Multiple R-squared:  0.7538, Adjusted R-squared:  0.7337
## F-statistic:  37.5 on 4 and 49 DF,  p-value: 2.387e-14
```

Conclusion: Before-use evaluation and Evaluation of the App are significant predictors for After-use evaluation.

Model2 (Intention of using Stad-up)

DV = Intention of using Stad-up (INTENT_SU)

Predictors: Before-use evaluation, Electric car experience, number of owned cars, evaluation of App

Stepwise regression

```
D_model2 <- D3[c(11, 38, 48, 50, 51)]
D_model2$INTENT_SU <- ifelse(D_model2$INTENT_SU == "Ja",1,0)

model_INTENT_SU <- regsubsets(INTENT_SU ~., data = D_model2, nvmax = 4,
                   = "seqrep")
summary(model_INTENT_SU)
```

```
## Subset selection object
## Call: regsubsets.formula(INTENT_SU ~ ., data = D_model2, nvmax = 4,
##     = "seqrep")
## 4 Variables  (and intercept)
##                 Forced in Forced out
## ECAR_EXPNee          FALSE      FALSE
## EVAL_SU_APP          FALSE      FALSE
## ATU_EVAL             FALSE      FALSE
## recode_NUM_CAR>1      FALSE      FALSE
## 1 subsets of each size up to 4
## Selection Algorithm: 'sequential replacement'
##          ECAR_EXPNee EVAL_SU_APP ATU_EVAL recode_NUM_CAR>1
## 1  ( 1 ) " "         " "         "*"      " "
## 2  ( 1 ) "*"         "*"         " "      " "
## 3  ( 1 ) "*"         "*"         " "      "*"
## 4  ( 1 ) "*"         "*"         "*"      "*"
```

Regression (to get coefficient estimates)

```
M_2 <- lm(INTENT_SU ~ ATU_EVAL + recode_NUM_CAR + ECAR_EXP +
            EVAL_SU_APP, data = D_model2)

summary(M_2)
```

```
##
## Call:
## lm(formula = INTENT_SU ~ ATU_EVAL + recode_NUM_CAR + ECAR_EXP +
##     EVAL_SU_APP, data = D_model2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.84344 -0.36991 -0.01273  0.35146  0.70273
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)      -0.22894    0.21559  -1.062   0.2935
## ATU_EVAL          0.06024    0.07968   0.756   0.4532
## recode_NUM_CAR>1 -0.22836    0.13083  -1.745   0.0872 .
```

```
## ECAR_SU_APP       0.33319    0.13648   2.441   0.0183 *
## EVAL_EXPNee       0.08760    0.07786   1.125   0.2660
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.4422 on 49 degrees of freedom
##   (58 observations deleted due to missingness)
## Multiple R-squared:  0.2535, Adjusted R-squared:  0.1926
## F-statistic:  4.16 on 4 and 49 DF,  p-value: 0.005584
```

Conclusion: Before-use evaluation and Number of owned cars are significant predictors for Intention of adopting Stad-up.for private use

Appendix J

R Codes for Potential User Survey Data Analysis

```
#install.packages("ggpubr")
#library(ggpubr)
library(rstatix)
```

```
##
## Attaching package: 'rstatix'
```

```
## The following object is masked from 'package:stats':
##
##     filter
```

```
library(tidyverse)
```

```
## ── Attaching packages ─────────────────────────────────────── tidyverse
1.3.0 ──
```

```
## ✓ ggplot2 3.3.3     ✓ purrr   0.3.4
## ✓ tibble  3.0.4     ✓ dplyr   1.0.2
## ✓ tidyr   1.1.2     ✓ stringr 1.4.0
## ✓ readr   1.4.0     ✓ forcats 0.5.0
```

```
## ── Conflicts ────────────────────────────────────────── tidyverse_conflicts() ──
## x dplyr::filter() masks rstatix::filter(), stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(readxl)
library(ggplot2)

#install.packages("rstanarm")
library(rstanarm)
```

```
## Loading required package: Rcpp
```

```
## Registered S3 methods overwritten by 'lme4':
##                          from
##   cooks.distance.influence.merMod car
##   influence.merMod               car
##   dfbeta.influence.merMod         car
##   dfbetas.influence.merMod        car
```

```
## This is rstanarm version 2.21.1
```

```
## - See https://mc-stan.org/rstanarm/articles/priors for changes to
default priors!
```

```
## - Default priors may change, so it's safest to specify priors, even if
equivalent to the defaults.
```

```
## - For execution on a local, multicore CPU with excess RAM we recommend
calling
```

```
##   options(mc.cores = parallel::detectCores())
```

```
library(gridExtra)
```

```
##
## Attaching package: 'gridExtra'
## The following object is masked from 'package:dplyr':
##
##     combine
options(mc.cores = 4)
```

##Import my Excel data (Citizen survey)

```
D <- read_xlsx("Citizen_data_0304.xlsx")
```

Data summary

```
sm <- summary(D)
sm
##        id          Progress        Duration        LANGUAGE
##  Min.   : 1.00   Min.   : 10.00   Min.   :  106.0   Length:90
##  1st Qu.:23.25   1st Qu.:100.00   1st Qu.:  316.5   Class :character
##  Median :45.50   Median :100.00   Median :  454.0   Mode  :character
##  Mean   :45.50   Mean   : 89.89   Mean   :  938.9
##  3rd Qu.:67.75   3rd Qu.:100.00   3rd Qu.:  627.8
##  Max.   :90.00   Max.   :100.00   Max.   :29087.0
##
##  GEN_VALUE_1        GEN_VALUE_2        CAR_VALUE_1        CAR_VALUE_2
##  Length:90          Length:90          Length:90          Length:90
##  Class :character   Class :character   Class :character   Class
:character
##  Mode  :character   Mode  :character   Mode  :character   Mode
:character
##
##
##
##
##  CAR_VALUE_DT           HS              NUM_DL           NUM_CAR
##  Length:90          Length:90          Length:90          Length:90
##  Class :character   Class :character   Class :character   Class
:character
##  Mode  :character   Mode  :character   Mode  :character   Mode
:character
##
##
##
##
##      ECAR            ECAR_EXP        KNOW_CARCOST       PERC_CARCOST
##  Length:90          Length:90          Length:90          Length:90
##  Class :character   Class :character   Class :character   Class
:character
##  Mode  :character   Mode  :character   Mode  :character   Mode
:character
##
##
##
##
```

```
##   TSP_OWNED          TSP_USE           PUB_TSP          PUB_TSP_SUB
##  Length:90         Length:90         Length:90         Length:90
##  Class :character   Class :character   Class :character   Class
:character
##  Mode  :character   Mode  :character   Mode  :character   Mode
:character
##
##
##
##
##  PUB_TSP_FREQ       PUB_TSP_USE        P_TSP_EVAL1     P_TSP_EVAL2
##  Length:90         Length:90         Min.   :2.000   Min.   :1.000
##  Class :character   Class :character   1st Qu.:3.000   1st Qu.:3.000
##  Mode  :character   Mode  :character   Median :4.000   Median :4.000
##                                       Mean   :3.413   Mean   :3.609
##                                       3rd Qu.:4.000   3rd Qu.:4.000
##                                       Max.   :5.000   Max.   :5.000
##                                       NA's   :44      NA's   :44
##   P_TSP_EVAL3     P_TSP_EVAL4     P_TSP_EVAL5     P_TSP_EVAL6
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.00
##  1st Qu.:3.000   1st Qu.:3.000   1st Qu.:3.000   1st Qu.:3.00
##  Median :4.000   Median :3.000   Median :4.000   Median :3.00
##  Mean   :3.804   Mean   :3.239   Mean   :3.565   Mean   :3.13
##  3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:3.00
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.00
##  NA's   :44      NA's   :44      NA's   :44      NA's   :44
##   C_TSP_SAT          SCAR_EXP          ATT_SCAR          INT_SCAR1
##  Length:90         Length:90         Length:90         Length:90
##  Class :character   Class :character   Class :character   Class
:character
##  Mode  :character   Mode  :character   Mode  :character   Mode
:character
##
##
##
##
##   INT_SCAR2          N_SCAR_USE            AVA0           PARK0
##  Length:90         Length:90         Min.   :1.000   Min.   :1.000
##  Class :character   Class :character   1st Qu.:1.000   1st Qu.:4.000
##  Mode  :character   Mode  :character   Median :2.000   Median :6.000
##                                       Mean   :2.365   Mean   :5.111
##                                       3rd Qu.:3.000   3rd Qu.:7.000
##                                       Max.   :6.000   Max.   :7.000
##                                       NA's   :27      NA's   :27
##      INSU0          KILOC0         SUBSC0        ACCESS0          OPT0
##  Min.   :1.000   Min.   :1.000   Min.   :1.00   Min.   :1.000   Min.
:1.000
##  1st Qu.:4.000   1st Qu.:2.000   1st Qu.:2.00   1st Qu.:2.000   1st
Qu.:4.000
##  Median :5.000   Median :4.000   Median :3.00   Median :3.000   Median
:6.000
##  Mean   :4.825   Mean   :3.746   Mean   :3.54   Mean   :3.317   Mean
:5.095
##  3rd Qu.:6.000   3rd Qu.:5.000   3rd Qu.:5.00   3rd Qu.:4.000   3rd
```

```
Qu.:7.000
##  Max.   :7.000   Max.   :7.000   Max.   :7.00   Max.   :7.000   Max.
:7.000
##  NA's   :27      NA's   :27      NA's   :27     NA's   :27      NA's   :27
##       AVA1          PARK1          INSU1          KILOC1        SUBSC1
##  Min.   :1.00   Min.   :3.00   Min.   :1.00   Min.   :1.0   Min.   :1.00
##  1st Qu.:2.25   1st Qu.:4.00   1st Qu.:2.75   1st Qu.:2.0   1st Qu.:1.00
##  Median :3.00   Median :5.50   Median :5.00   Median :3.5   Median :2.00
##  Mean   :3.20   Mean   :5.30   Mean   :4.70   Mean   :3.5   Mean   :2.90
##  3rd Qu.:4.00   3rd Qu.:6.75   3rd Qu.:6.75   3rd Qu.:5.0   3rd Qu.:4.75
##  Max.   :6.00   Max.   :7.00   Max.   :7.00   Max.   :7.0   Max.   :6.00
##  NA's   :80     NA's   :80     NA's   :80     NA's   :80    NA's   :80
##     ACCESS1          OPT1       INTENT_SU         ATT_SU_BIKE
##  Min.   :1.00   Min.   :2.00   Length:90          Length:90
##  1st Qu.:2.25   1st Qu.:4.25   Class :character   Class :character
##  Median :3.00   Median :6.00   Mode  :character   Mode  :character
##  Mean   :3.20   Mean   :5.20
##  3rd Qu.:3.75   3rd Qu.:6.00
##  Max.   :7.00   Max.   :7.00
##  NA's   :80     NA's   :80
##  ATT_SU_TRAIN       ATT_SU_ECAR          FAM_SM            ZIP code
##  Length:90          Length:90          Length:90         Min.   :7511
##  Class :character   Class :character   Class :character   1st Qu.:7512
##  Mode  :character   Mode  :character   Mode  :character   Median :7514
##                                                           Mean   :7517
##                                                           3rd Qu.:7514
##                                                           Max.   :7600
##                                                           NA's   :23
##     GENER              AGE            WORK_STAT            EDU
##  Length:90          Length:90          Length:90         Length:90
##  Class :character   Class :character   Class :character   Class
:character
##  Mode  :character   Mode  :character   Mode  :character   Mode
:character
##
##
##
##
```

```
sapply(D, class)
```

```
##          id    Progress    Duration    LANGUAGE  GEN_VALUE_1
GEN_VALUE_2
##   "numeric"   "numeric"   "numeric"  "character"  "character"
"character"
##  CAR_VALUE_1  CAR_VALUE_2 CAR_VALUE_DT          HS       NUM_DL
NUM_CAR
##  "character"  "character"  "character"  "character"  "character"
"character"
##        ECAR     ECAR_EXP KNOW_CARCOST PERC_CARCOST    TSP_OWNED
TSP_USE
##  "character"  "character"  "character"  "character"  "character"
"character"
##     PUB_TSP  PUB_TSP_SUB PUB_TSP_FREQ  PUB_TSP_USE  P_TSP_EVAL1
P_TSP_EVAL2
```

```
##  "character"  "character"  "character"  "character"    "numeric"
"numeric"
##  P_TSP_EVAL3  P_TSP_EVAL4  P_TSP_EVAL5  P_TSP_EVAL6    C_TSP_SAT
SCAR_EXP
##    "numeric"    "numeric"    "numeric"    "numeric"  "character"
"character"
##     ATT_SCAR    INT_SCAR1    INT_SCAR2   N_SCAR_USE         AVA0
PARK0
##  "character"  "character"  "character"  "character"    "numeric"
"numeric"
##        INSU0       KILOC0       SUBSC0      ACCESS0         OPT0
AVA1
##    "numeric"    "numeric"    "numeric"    "numeric"    "numeric"
"numeric"
##        PARK1        INSU1       KILOC1       SUBSC1      ACCESS1
OPT1
##    "numeric"    "numeric"    "numeric"    "numeric"    "numeric"
"numeric"
##    INTENT_SU  ATT_SU_BIKE ATT_SU_TRAIN  ATT_SU_ECAR       FAM_SM     ZIP
code
##  "character"  "character"  "character"  "character"  "character"
"numeric"
##        GENER          AGE    WORK_STAT          EDU
##  "character"  "character"  "character"  "character"
```

Create a new variable: calculate Public transport evaluation score (P_TSP_EVAL): generated by averaging the scores for the six service rating dimensions

```
D2 <- D

cols.num <- c("P_TSP_EVAL1","P_TSP_EVAL2","P_TSP_EVAL3","P_TSP_EVAL4",
              "P_TSP_EVAL5","P_TSP_EVAL6")
D2[cols.num] <- sapply(D2[cols.num],as.numeric)

D2$P_TSP_EVAL <-
(D2$P_TSP_EVAL1+D2$P_TSP_EVAL2+D2$P_TSP_EVAL3+D2$P_TSP_EVAL4+
                  D2$P_TSP_EVAL5+D2$P_TSP_EVAL6)/6
```

##Combine ranking (of motivation factors) columns (suffix "0" means No shared car experience; suffix "1" means Have shared car experience)

```
D3 <- D[,35:48]
D3[is.na(D3)] <- 0

D3$AVA <- D3$AVA0 + D3$AVA1
D3$PARK <- D3$PARK0 + D3$PARK1
D3$INSU <- D3$INSU0 + D3$INSU1
D3$KILOC <- D3$KILOC0 + D3$KILOC1
D3$SUBSC <- D3$SUBSC0 + D3$SUBSC1
D3$ACCESS<- D3$ACCESS0 + D3$ACCESS1
D3$OPT<- D3$OPT0 + D3$OPT1

D3[D3 == 1 ] <- 1
```

```
D3[D3 == 2 ] <- 6/7
D3[D3 == 3 ] <- 5/7
D3[D3 == 4 ] <- 4/7
D3[D3 == 5 ] <- 3/7
D3[D3 == 6 ] <- 2/7
D3[D3 == 7 ] <- 1/7
```

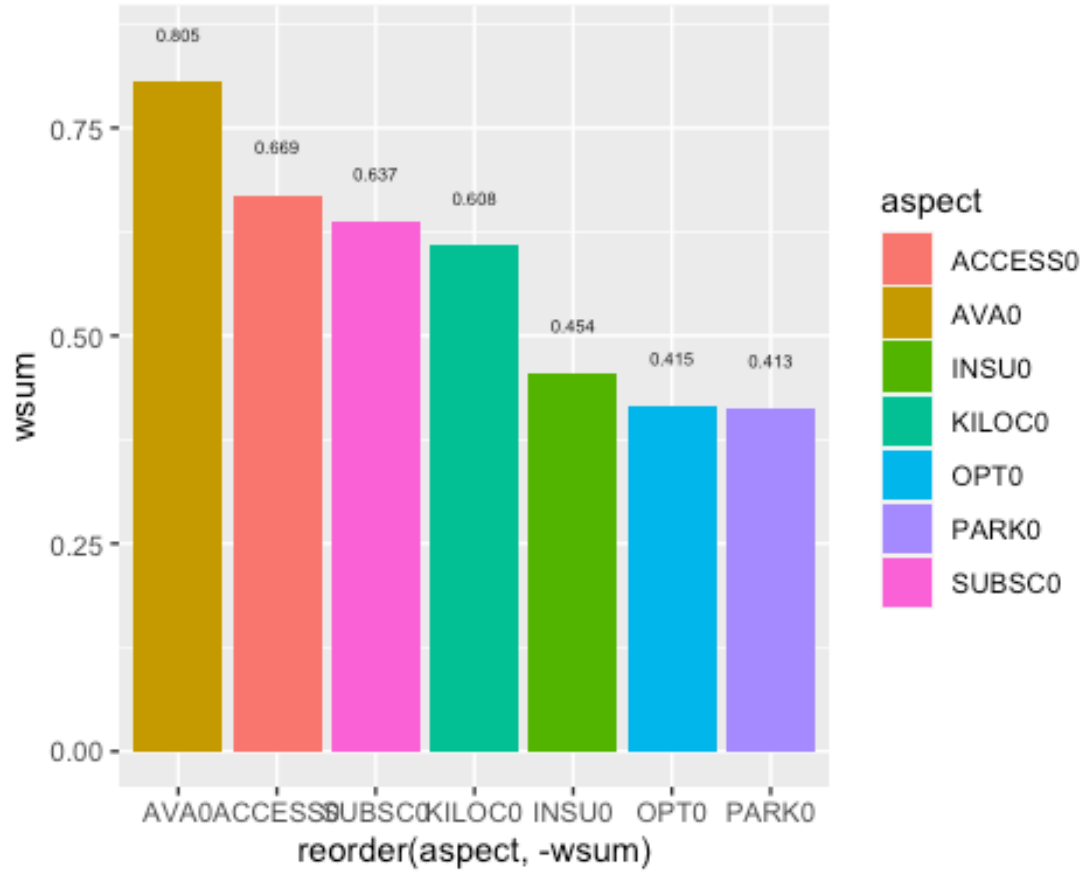
Conclusion: Availability is the most important to all people investigated, whether those that are or are not willing to use Shared Cars in the future. It seems that costs matter more to those who affirm their intention of using shared cars than those who don't intend to do so.

##Rankings of motivations factors to NO shared-car experience Ps

```
D3_1 <- D3[,1:7]
D3_1 %>%
   filter(D3_1 > 0) %>%
   gather(key = "aspect", value = "value") %>%
   group_by(aspect) %>%
   summarise(wsum = round(mean(value, na.rm = T), 3)) %>%
   ggplot(aes(x = reorder(aspect,-wsum), y = wsum)) +
   geom_col(aes(fill = aspect), position="dodge") +
   geom_line(lty = 3) +
   geom_text(aes(label=wsum, y=wsum+0.05),
             position=position_dodge(0.9), size = 2, vjust=0)
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## geom_path: Each group consists of only one observation. Do you need to
adjust
## the group aesthetic?
```



##Use the data to make charts in Excel

```
D3_1 %>%
   filter(D3_1 > 0) %>%
   gather(key = "aspect", value = "value") %>%
   group_by(aspect) %>%
   summarise(wsum = mean(value, na.rm = T))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## # A tibble: 7 x 2
##   aspect   wsum
##   <chr>   <dbl>
## 1 ACCESS0 0.669
## 2 AVA0    0.805
## 3 INSU0   0.454
## 4 KILOC0  0.608
## 5 OPT0    0.415
## 6 PARK0   0.413
## 7 SUBSC0  0.637
```

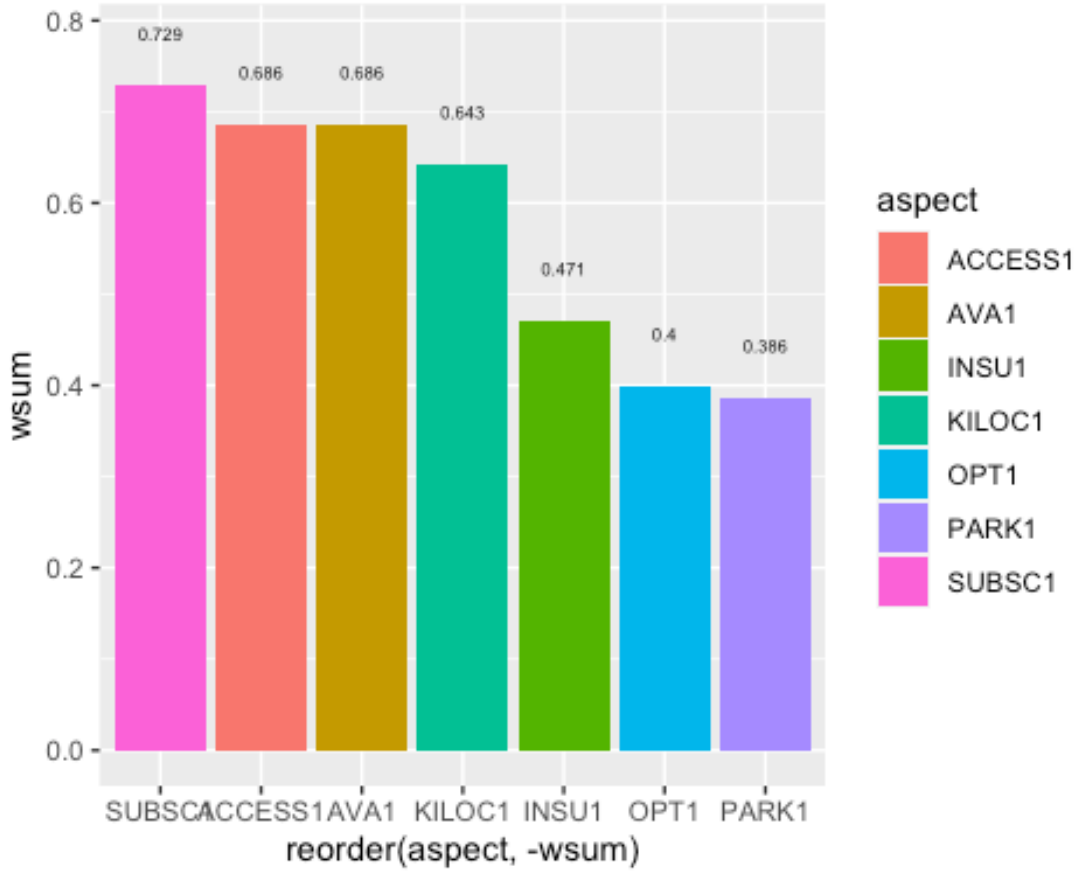
##Rankings of motivations factors to Ps that have shared-car experience

```
D3_2 <- D3[,8:14]
D3_2 %>%
   filter(D3_2 > 0) %>%
   gather(key = "aspect", value = "value") %>%
   group_by(aspect) %>%
   summarise(wsum = round(mean(value, na.rm = T), 3)) %>%
```

```
   ggplot(aes(x = reorder(aspect,-wsum), y = wsum)) +
   geom_col(aes(fill = aspect), position="dodge") +
   geom_line(lty = 3) +
   geom_text(aes(label=wsum, y=wsum+0.05),
             position=position_dodge(0.9), size = 2, vjust=0)
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## geom_path: Each group consists of only one observation. Do you need to
adjust
## the group aesthetic?
```




```
D3_2 %>%
   filter(D3_2 > 0) %>%
   gather(key = "aspect", value = "value") %>%
   group_by(aspect) %>%
   summarise(wsum = mean(value, na.rm = T))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
## # A tibble: 7 x 2
##   aspect   wsum
##   <chr>   <dbl>
## 1 ACCESS1 0.686
## 2 AVA1    0.686
## 3 INSU1   0.471
## 4 KILOC1  0.643
## 5 OPT1    0.40
## 6 PARK1   0.386
## 7 SUBSC1  0.729
```

Update the dataset with the additional ranking columns

```
col_names <- c("AVA", "PARK", "INSU", "KILOC", "SUBSC", "ACCESS", "OPT")

D4 <- cbind.data.frame(D2, D3[col_names])
```

Recode some categorical variables

```
D4$C_TSP_SAT <- recode(D4$C_TSP_SAT, "Very satisfied" = 5, "Satisfied" =
4, "Neither satisfied nor dissatisfied" = 3, "Dissatisfied" = 2, "Very
dissatisfied" = 1)

D4$ATT_SCAR <- recode(D4$ATT_SCAR, "Very positive" = 5, "Positive" = 4,
"Neutral" = 3, "Negative" = 2, "Very negative" = 1)

D4$GEN_VALUE_1 <- recode(D4$GEN_VALUE_1, "Very important" = 6, "Important"
= 5, "Somewhat important" = 4, "Somewhat unimportant" = 3, "Unimportant" =
2, "Very unimportant" = 1)

D4$GEN_VALUE_2 <- recode(D4$GEN_VALUE_2, "Very important" = 6, "Important"
= 5, "Somewhat important" = 4, "Somewhat unimportant" = 3, "Unimportant" =
2, "Very unimportant" = 1)

D4$CAR_VALUE_1 <- recode(D4$CAR_VALUE_1, "Strongly agree" = 5, "Agree" =
4, "Neutral" = 3, "Disagree" = 2, "Strongly disagree" = 1)

D4$CAR_VALUE_2 <- recode(D4$CAR_VALUE_2, "Strongly agree" = 5, "Agree" =
4, "Neutral" = 3, "Disagree" = 2, "Strongly disagree" = 1)

D4$CAR_VALUE_DT <- recode(D4$CAR_VALUE_DT, "Very important" = 6,
"Important" = 5, "Somewhat important" = 4, "Somewhat unimportant" = 3,
"Unimportant" = 2, "Very unimportant" = 1)

D4$recode_NUM_CAR = ifelse(D4$NUM_CAR <= 1, "<=1",">1")
```

#Crosstables and Chi tests

(1) Investigate relation between Number of owned cars and intention to use Stad-up (No / Yes) ; ~ intention to use shared cars (No / Yes)

```
mytable1 <- xtabs(~recode_NUM_CAR+INTENT_SU, data = D4)
ftable(mytable1) # print table
```

```
##               INTENT_SU No Yes
## recode_NUM_CAR
## <=1                     27  29
## >1                      12   3
```

```
summary(mytable1) # chi-square test of indepedence
```

```
## Call: xtabs(formula = ~recode_NUM_CAR + INTENT_SU, data = D4)
## Number of cases in table: 71
## Number of factors: 2
```

```
## Test for independence of all factors:
##  Chisq = 4.828, df = 1, p-value = 0.028
```

```
mytable1_2 <- xtabs(~recode_NUM_CAR+INT_SCAR2, data = D4)
ftable(mytable1_2) # print table
```

```
##               INT_SCAR2 No Yes
## recode_NUM_CAR
## <=1                     25  30
## >1                      15   2
```

```
summary(mytable1_2) # chi-square test of indepedence
```

```
## Call: xtabs(formula = ~recode_NUM_CAR + INT_SCAR2, data = D4)
## Number of cases in table: 72
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 9.626, df = 1, p-value = 0.001919
```

Conclusion: the more cars a household have, the less willing they are to adopt Shared Mobility in the future.

(2) Investigate relationship between Electric car experience & Intention to use Stad-up; ~ intention to use shared cars (No / Yes)

```
mytable2 <- xtabs(~ECAR_EXP+INTENT_SU, data = D4)
ftable(mytable2) # print table
```

```
##          INTENT_SU No Yes
## ECAR_EXP
## No                27  24
## Yes               12   8
```

```
summary(mytable2)
```

```
## Call: xtabs(formula = ~ECAR_EXP + INTENT_SU, data = D4)
## Number of cases in table: 71
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 0.28914, df = 1, p-value = 0.5908
```

```
mytable2_2 <- xtabs(~ECAR_EXP+INT_SCAR2, data = D4)
ftable(mytable2_2) # print table
```

```
##          INT_SCAR2 No Yes
## ECAR_EXP
## No                30  24
## Yes               10   8
```

```
summary(mytable2_2)
```

```
## Call: xtabs(formula = ~ECAR_EXP + INT_SCAR2, data = D4)
## Number of cases in table: 72
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 0, df = 1, p-value = 1
```

Result: non-significant

(3) Investigate relationship between Shared car experience & Intention to use Stad-up; ~ intention to use shared cars (No / Yes)

```
mytable3 <- xtabs(~SCAR_EXP+INTENT_SU, data = D4)
ftable(mytable3) # print table
```

```
##          INTENT_SU No Yes
## SCAR_EXP
## No                34  27
## Yes                5   5
```

```
summary(mytable3)
```

```
## Call: xtabs(formula = ~SCAR_EXP + INTENT_SU, data = D4)
## Number of cases in table: 71
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 0.11425, df = 1, p-value = 0.7354
##  Chi-squared approximation may be incorrect
```

```
mytable3_2 <- xtabs(~SCAR_EXP+INT_SCAR2, data = D4)
ftable(mytable3_2) # print table
```

```
##          INT_SCAR2 No Yes
## SCAR_EXP
## No                40  32
```

```
summary(mytable3_2)
```

```
## Call: xtabs(formula = ~SCAR_EXP + INT_SCAR2, data = D4)
## Number of cases in table: 72
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 0, df = 0, p-value = 1
```

Result: non-significant

(4) Investigate relationship between Intention of using Shared Mobility and Intention of adopting Stad-up

```
mytable4 <- xtabs(~INT_SCAR2 + INTENT_SU, data = D2)
ftable(mytable4) # print table
```

```
##           INTENT_SU No Yes
## INT_SCAR2
## No                 25   7
## Yes                 8  20
```

```
summary(mytable4) # chi-square test of indepedence
```

```
## Call: xtabs(formula = ~INT_SCAR2 + INTENT_SU, data = D2)
## Number of cases in table: 60
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 14.816, df = 1, p-value = 0.0001185
```

Conclusion: those who are more receptive to Shared mobility are also more willing to accept Stad-up service.

(5) Investigate relationship between Public transport usage (Yes / No) and Intention of using shared cars (No / Yes) ; ~ intention to use shared cars (No / Yes)

```
mytable5 <- xtabs(~PUB_TSP+INT_SCAR2, data = D4)
ftable(mytable5) # print table
```

```
##         INT_SCAR2 No Yes
## PUB_TSP
## No                24   7
## Yes               16  25
```

```
summary(mytable5) # chi-square test of indepedence
```

```
## Call: xtabs(formula = ~PUB_TSP + INT_SCAR2, data = D4)
## Number of cases in table: 72
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 10.539, df = 1, p-value = 0.001169
```

Conclusion: Those who don't use Public transport also don't want to use Shared car systems.

(5_2) Investigate relationship between Public transport usage (Yes / No) and Intention of using Stad-up (No / Yes)

```
mytable5_2 <- xtabs(~PUB_TSP+INTENT_SU, data = D4)
ftable(mytable5_2) # print table
```

```
##         INTENT_SU No Yes
## PUB_TSP
## No                21   7
## Yes               18  25
```

```
summary(mytable5_2) # chi-square test of indepedence
```

```
## Call: xtabs(formula = ~PUB_TSP + INTENT_SU, data = D4)
## Number of cases in table: 71
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 7.523, df = 1, p-value = 0.006093
```

(6) Investigate relationship between Demographics (householad size) and Intention of using shared cars (No / Yes)

```
# Because HS mostly fall into the level "2 people"
D4_HS <- D4 %>%
    mutate_at("HS", funs(recode(., '1 person' = '1 person',
                                '2 persons' = '2 persons',
                                '3 persons'= '>= 3 persons',
                                '4 persons' = '>= 3 persons',
                                'More than 4 persons' = '>= 3 persons')))
```

```
## Warning: `funs()` is deprecated as of dplyr 0.8.0.
## Please use a list of either functions or lambdas:
##
```

```
##   # Simple named list:
##   list(mean = mean, median = median)
##
##   # Auto named with `tibble::lst()`:
##   tibble::lst(mean, median)
##
##   # Using lambdas
##   list(~ mean(., trim = .2), ~ median(., na.rm = TRUE))
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_warnings()` to see where this warning was
generated.
```

```
mytable6 <- xtabs(~HS+INT_SCAR2, data = D4_HS)
ftable(mytable6) # print table
```

```
##             INT_SCAR2 No Yes
## HS
## >= 3 persons          17   9
## 1 person               3   9
## 2 persons             20  14
```

```
summary(mytable6)
```

```
## Call: xtabs(formula = ~HS + INT_SCAR2, data = D4_HS)
## Number of cases in table: 72
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 5.702, df = 2, p-value = 0.05779
```

Conclusion: it seems that those living alone have more positive intention to use shared cars compared to those living with others.

(7) Investigate relationship between Demographics (age) and Intention of using shared cars (No / Yes)

```
D4_AGE <- D4 %>%
   select(AGE, INT_SCAR2)

D4_AGE <- na.omit(D4_AGE)

mytable7 <- xtabs(~AGE+INT_SCAR2, data = D4_AGE)
#summary(mytable7)

fisher.test(mytable7)
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  mytable7
## p-value = 0.1542
## alternative hypothesis: two.sided
```

(8) Investigate relationship between Demographics (work situation) and Intention of using shared cars (No / Yes)

```
D4_WS <- D4 %>%
    mutate_at("WORK_STAT", funs(recode(., 'Otherwise, namely..' =
                                    'Unemployed',
                                'Retired' = 'Unemployed',
                                'Unemployed, looking for work' =
                                   'Unemployed',
                                .default = 'Employed' )))

mytable8 <- xtabs(~WORK_STAT+INT_SCAR2, data = D4_WS)
ftable(mytable8) # print table
```

```
##            INT_SCAR2 No Yes
## WORK_STAT
## Employed             21  16
## Unemployed            8  12
```

```
summary(mytable8) # chi-square test of indepedence
```

```
## Call: xtabs(formula = ~WORK_STAT + INT_SCAR2, data = D4_WS)
## Number of cases in table: 57
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 1.4586, df = 1, p-value = 0.2272
```

Result: work status has no effect on intention to use shared cars.

(9) Investigate relationship between Demographics (gender) and Intention of using shared cars (No / Yes)

```
mytable9 <- xtabs(~GENER+INT_SCAR2, data = D4)
ftable(mytable9) # print table
```

```
##       INT_SCAR2 No Yes
## GENER
## Man              15  15
## Woman            14  13
```

```
summary(mytable9)
```

```
## Call: xtabs(formula = ~GENER + INT_SCAR2, data = D4)
## Number of cases in table: 57
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 0.019499, df = 1, p-value = 0.8889
```

Result: Gender has no effect on intention to use shared cars.

(10) Investigate relationship between Demographics (householad size) and Intention of using Stad-up (No / Yes)

```
# Because HS mostly fall into the level "2 people"
D4_HS <- D4 %>%
    mutate_at("HS", funs(recode(., '1 person' = '1 person',
```

```
                                '2 persons' = '2 persons',
                                '3 persons'= '>= 3 persons',
                                '4 persons' = '>= 3 persons',
                                'More than 4 persons' = '>= 3 persons')))

mytable10 <- xtabs(~HS+INTENT_SU, data = D4_HS)
ftable(mytable10) # print table
```

```
##             INTENT_SU No Yes
## HS
## >= 3 persons          15  11
## 1 person               5   8
## 2 persons             19  13
```

```
summary(mytable10)
```

```
## Call: xtabs(formula = ~HS + INTENT_SU, data = D4_HS)
## Number of cases in table: 71
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 1.7597, df = 2, p-value = 0.4149
```

Result: non-significant

(11) Investigate relationship between Demographics (age) and Intention of using Stad-up (No / Yes)

```
D4_AGE <- D4 %>%
   select(AGE, INTENT_SU)

D4_AGE <- na.omit(D4_AGE)

mytable11 <- xtabs(~AGE+INTENT_SU, data = D4_AGE)
#summary(mytable11)

fisher.test(mytable11)
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  mytable11
## p-value = 0.188
## alternative hypothesis: two.sided
```

Result: non-significant

(12) Investigate relationship between Demographics (householad size; age;work situation; gender) and Intention of using shared cars (No / Yes)

```
D4_WS <- D4 %>%
     mutate_at("WORK_STAT", funs(recode(., 'Otherwise, namely..' =
                                      'Unemployed',
                                'Retired' = 'Unemployed',
                                'Unemployed, looking for work' =
```

```
                                'Unemployed',
                               .default = 'Employed' )))

mytable12 <- xtabs(~WORK_STAT+INTENT_SU, data = D4_WS)
ftable(mytable12) # print table
```

```
##            INTENT_SU No Yes
## WORK_STAT
## Employed             24  21
## Unemployed           12  11
```

```
summary(mytable12) # chi-square test of indepedence
```

```
## Call: xtabs(formula = ~WORK_STAT + INTENT_SU, data = D4_WS)
## Number of cases in table: 68
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 0.008213, df = 1, p-value = 0.9278
```

Result: non-significant

(13) Investigate relationship between Demographics (householad size; age;work situation; gender) and Intention of using shared cars (No / Yes)

```
mytable13 <- xtabs(~GENER+INTENT_SU, data = D4)
ftable(mytable13) # print table
```

```
##       INTENT_SU No Yes
## GENER
## Man             21  17
## Woman           15  15
```

```
summary(mytable13)
```

```
## Call: xtabs(formula = ~GENER + INTENT_SU, data = D4)
## Number of cases in table: 68
## Number of factors: 2
## Test for independence of all factors:
##  Chisq = 0.1864, df = 1, p-value = 0.6659
```

Result: non-significant

One-way ANOVA

(1) Grouping variable = Public transport usage (Yes/No); DV = Attitude toward shared car

```
D4$PUB_TSP <- ifelse(D4$PUB_TSP == "Yes", 1, 0)

anova_result1 <- aov(ATT_SCAR ~ PUB_TSP, data = D4)
summary(anova_result1)
```

```
##             Df Sum Sq Mean Sq F value   Pr(>F)
## PUB_TSP      1  16.43  16.432   13.12 0.000501 ***
```

```
## Residuals   83 103.92   1.252
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 5 observations deleted due to missingness
```

(2) Grouping variable = recode_NUM_CAR (<= 1 vs >1); DV = Attitude toward shared car

```
D4$recode_NUM_CAR <- as.factor(D4$recode_NUM_CAR)

anova_result2 <- aov(ATT_SCAR ~ recode_NUM_CAR, data = D4)
summary(anova_result2)
```

```
##               Df Sum Sq Mean Sq F value   Pr(>F)
## recode_NUM_CAR  1  15.77   15.77   12.51 0.000664 ***
## Residuals      83 104.58    1.26
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 5 observations deleted due to missingness
```

Result: significant

(3) Grouping variable = Electric car experience (Yes/No); DV = Attitude toward shared car

```
D4$ECAR_EXP <- as.factor(D4$ECAR_EXP)

anova_result3 <- aov(ATT_SCAR ~ ECAR_EXP, data = D4)
summary(anova_result3)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## ECAR_EXP     1   5.02    5.02   3.612 0.0608 .
## Residuals   83 115.33    1.39
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 5 observations deleted due to missingness
```

Result: marginally significant

(4) Grouping variable = Shared car experience (Yes/No); DV = Attitude toward shared car

```
D4$SCAR_EXP <- as.factor(D4$SCAR_EXP)

anova_result4 <- aov(ATT_SCAR ~ SCAR_EXP, data = D4)
summary(anova_result4)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## SCAR_EXP     1    0.0  0.0013   0.001  0.976
## Residuals   83  120.3  1.4500
## 5 observations deleted due to missingness
```

Result: non-significant

(householad size; age;work situation; gender) ## (5) Grouping variable = age; DV = Attitude toward shared car

```
D4_AGE_2 <- D4 %>%
   select(AGE, ATT_SCAR)

D4_AGE_2 <- na.omit(D4_AGE_2)

D4_AGE_2$AGE <- as.factor(D4_AGE_2$AGE)

anova_result5 <- aov(ATT_SCAR ~ AGE, data = D4_AGE_2)
summary(anova_result5)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## AGE          3   7.94   2.648   1.888   0.14
## Residuals   64  89.75   1.402
```

Result: non-significant

(6) Grouping variable = work situation; DV = Attitude toward shared car

```
D4_WS$WORK_STAT <- as.factor(D4_WS$WORK_STAT)

anova_result6 <- aov(ATT_SCAR ~ WORK_STAT, data = D4_WS)
summary(anova_result6)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## WORK_STAT    1   0.13  0.1337    0.09  0.765
## Residuals   66  97.56  1.4781
## 22 observations deleted due to missingness
```

Result: non-significant

(7) Grouping variable = household size; DV = Attitude toward shared car

```
D4_HS$HS <- as.factor(D4_HS$HS)

anova_result7 <- aov(ATT_SCAR ~ HS, data = D4_HS)
summary(anova_result7)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## HS           2   6.75   3.373   2.434  0.094 .
## Residuals   82 113.61   1.385
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## 5 observations deleted due to missingness
```

```
TukeyHSD(anova_result7)
```

```
##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = ATT_SCAR ~ HS, data = D4_HS)
##
## $HS
```

```
##                             diff        lwr       upr     p adj
## 1 person->= 3 persons  0.52688172 -0.35681461 1.4105780 0.3337896
## 2 persons->= 3 persons 0.60380480 -0.07225713 1.2798667 0.0896807
## 2 persons-1 person     0.07692308 -0.77670670 0.9305529 0.9748239
```

Conclusion: it seems that those living in a two-people household have more positive attitude to use Stad-up compared to those who either lives alone or lives with at least two others.

(8) Grouping variable = gender; DV = Attitude toward shared car

```
D4$GENER <- as.factor(D4$GENER)

anova_result8 <- aov(ATT_SCAR ~ GENER, data = D4)
summary(anova_result8)
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## GENER        1   3.46   3.461   2.424  0.124
## Residuals   66  94.23   1.428
## 22 observations deleted due to missingness
```

Result: non-significant

Correlation analysis

Correlation between CAR_VALUE_1(Functionality of car), CAR_VALUE_2 (Car as self-identity) CAR_VALUE_DT (car important to one's daily travel)

(if too high correlation, then just choose one as predictor for DVs)

```
D_test <- D4 %>%
   select(CAR_VALUE_1, CAR_VALUE_2, CAR_VALUE_DT) %>%
   mutate(CAR_VALUE_2 = 6-CAR_VALUE_2)
   #filter(CAR_VALUE_DT > 0)

corr_1 <- cor.test(D_test$CAR_VALUE_2, D_test$CAR_VALUE_DT,
                   = 'pearson')
corr_1
```

```
##
##  Pearson's product-moment correlation
##
## data:  D_test$CAR_VALUE_2 and D_test$CAR_VALUE_DT
## t = -2.4052, df = 65, p-value = 0.01902
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.49228385 -0.04903988
## sample estimates:
##       cor
## -0.2858809
```

```
corr_2 <- cor.test(D_test$CAR_VALUE_1, D_test$CAR_VALUE_2,
                   = 'pearson')
corr_2
```

```
##
##  Pearson's product-moment correlation
##
## data:  D_test$CAR_VALUE_1 and D_test$CAR_VALUE_2
## t = 2.0402, df = 84, p-value = 0.04447
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  0.005676107 0.410276933
## sample estimates:
##       cor
## 0.2172901
```

```
corr_3 <- cor.test(D_test$CAR_VALUE_1, D_test$CAR_VALUE_DT,
                   = 'pearson')
corr_3
```

```
##
##  Pearson's product-moment correlation
##
## data:  D_test$CAR_VALUE_1 and D_test$CAR_VALUE_DT
## t = -0.23566, df = 65, p-value = 0.8144
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.2675479  0.2124829
## sample estimates:
##         cor
## -0.02921698
```

Weak correlations or no correlation between each two of the variables.

Generate a variable as “Perceived Functionality value of a car”

```
D_test <- D4 %>%
   select(CAR_VALUE_1, CAR_VALUE_2) %>%
   mutate(CAR_VALUE_2 = 6-CAR_VALUE_2)



CAR_VALUE_ALL <- rowMeans(D_test, na.rm = TRUE)
CAR_VALUE_ALL <- as.data.frame(CAR_VALUE_ALL)

D4 <- cbind.data.frame(D4, CAR_VALUE_ALL)
```

#Regression

Load the packages

```
#library(tidyverse) #already exist
#library(caret) #already exist

library(leaps)  #leaps() performs an exhaustive search for the best
subsets of the variables in x for predicting y in linear regression
```

##Stepwise regression ##DV = Attitude towards Shared cars (continuous)
##Predictors: Genaral consumption value 1&2, Car-related value 1&2&DT, number of

cars owned, Electric car experience, Shared car experience, currenpt personal transport satisfaction, usage of public transport (Yes / No)

```
D6 <- D4 %>%
   filter(ATT_SCAR > 0)

D_model1 <- D6[c(5, 6, 9, 29, 31, 67, 19, 68)]

model_ATT_SCAR <- regsubsets(ATT_SCAR ~., data = D_model1, nvmax = 5,
                    = "seqrep")

summary(model_ATT_SCAR)
```

```
## Subset selection object
## Call: regsubsets.formula(ATT_SCAR ~ ., data = D_model1, nvmax = 5,
##     = "seqrep")
## 7 Variables  (and intercept)
##                 Forced in Forced out
## GEN_VALUE_1          FALSE      FALSE
## GEN_VALUE_2          FALSE      FALSE
## CAR_VALUE_DT         FALSE      FALSE
## C_TSP_SAT            FALSE      FALSE
## recode_NUM_CAR>1     FALSE      FALSE
## PUB_TSP              FALSE      FALSE
## CAR_VALUE_ALL        FALSE      FALSE
## 1 subsets of each size up to 5
## Selection Algorithm: 'sequential replacement'
##          GEN_VALUE_1 GEN_VALUE_2 CAR_VALUE_DT C_TSP_SAT recode_NUM_CAR>1
## 1  ( 1 ) " "         " "         "*"          " "       " "
## 2  ( 1 ) " "         " "         "*"          " "       "*"
## 3  ( 1 ) " "         " "         "*"          " "       "*"
## 4  ( 1 ) "*"         "*"         "*"          "*"       " "
## 5  ( 1 ) "*"         " "         "*"          "*"       "*"
##          PUB_TSP CAR_VALUE_ALL
## 1  ( 1 ) " "     " "
## 2  ( 1 ) " "     " "
## 3  ( 1 ) " "     "*"
## 4  ( 1 ) " "     " "
## 5  ( 1 ) " "     "*"
```

Regression -> look at the coefficients

Note that in stepwise regression PUB_TSP was removed

```
M_1a <- lm(ATT_SCAR ~ GEN_VALUE_1 + GEN_VALUE_2 + CAR_VALUE_ALL +
             CAR_VALUE_DT + recode_NUM_CAR + C_TSP_SAT,
          data = D_model1)

summary(M_1a)
```

```
##
## Call:
## lm(formula = ATT_SCAR ~ GEN_VALUE_1 + GEN_VALUE_2 + CAR_VALUE_ALL +
##     CAR_VALUE_DT + recode_NUM_CAR + C_TSP_SAT, data = D_model1)
##
```

```
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.20898 -0.60994  0.02054  0.53036  1.93493
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)       3.47715    1.25950   2.761  0.00764 **
## GEN_VALUE_1       0.16684    0.13759   1.213  0.23005
## GEN_VALUE_2      -0.06911    0.14299  -0.483  0.63061
## CAR_VALUE_ALL     0.12588    0.15209   0.828  0.41113
## CAR_VALUE_DT     -0.20459    0.07937  -2.578  0.01242 *
## recode_NUM_CAR>1 -0.44758    0.29251  -1.530  0.13123
## C_TSP_SAT        -0.11672    0.14434  -0.809  0.42191
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9877 on 60 degrees of freedom
##   (18 observations deleted due to missingness)
## Multiple R-squared:  0.2634, Adjusted R-squared:  0.1898
## F-statistic: 3.576 on 6 and 60 DF,  p-value: 0.004276
```

Conclusion: Only car-related value_DT, i.e., the extent to which one views cars as a daily transport means, is a significant predictor for Attitude towards Shared cars.

##Stepwise regression ##DV = INTention to use shared car #Had to remove SCAR_EXP as predictor, since all were “No”.

```
D7 <- D4 %>%
   filter(INT_SCAR2 == "Yes" | INT_SCAR2 == "No") %>%
   mutate(recode_INT_SCAR2 = ifelse(INT_SCAR2 == "Yes", 1, 0))

D_model2 <- D7[c(69, 31, 5, 6, 9, 29, 67, 19, 68)]

model_INT_SCAR2 <- regsubsets(recode_INT_SCAR2 ~., data = D_model2, nvmax
= 5,
                   = "seqrep")

summary(model_INT_SCAR2)
```

```
## Subset selection object
## Call: regsubsets.formula(recode_INT_SCAR2 ~ ., data = D_model2, nvmax =
5,
##     = "seqrep")
## 8 Variables  (and intercept)
##                 Forced in Forced out
## ATT_SCAR            FALSE      FALSE
## GEN_VALUE_1         FALSE      FALSE
## GEN_VALUE_2         FALSE      FALSE
## CAR_VALUE_DT        FALSE      FALSE
## C_TSP_SAT           FALSE      FALSE
## recode_NUM_CAR>1     FALSE      FALSE
## PUB_TSP             FALSE      FALSE
## CAR_VALUE_ALL        FALSE      FALSE
## 1 subsets of each size up to 5
## Selection Algorithm: 'sequential replacement'
```

```
##          ATT_SCAR GEN_VALUE_1 GEN_VALUE_2 CAR_VALUE_DT C_TSP_SAT
## 1  ( 1 ) "*"      " "         " "         " "          " "
## 2  ( 1 ) "*"      " "         " "         " "          " "
## 3  ( 1 ) "*"      " "         " "         " "          " "
## 4  ( 1 ) "*"      " "         " "         " "          "*"
## 5  ( 1 ) "*"      " "         " "         " "          "*"
##          recode_NUM_CAR>1 PUB_TSP CAR_VALUE_ALL
## 1  ( 1 ) " "              " "     " "
## 2  ( 1 ) "*"              " "     " "
## 3  ( 1 ) "*"              "*"     " "
## 4  ( 1 ) "*"              "*"     " "
## 5  ( 1 ) "*"              "*"     "*"
```

##Removed GEN_VALUE_1, GEN_VALUE_2, CAR_VALUE_DT

```
M_2 <- lm(recode_INT_SCAR2 ~ ATT_SCAR + CAR_VALUE_ALL +
             recode_NUM_CAR + C_TSP_SAT + PUB_TSP,
          data = D_model2)

summary(M_2)
```

```
##
## Call:
## lm(formula = recode_INT_SCAR2 ~ ATT_SCAR + CAR_VALUE_ALL +
recode_NUM_CAR +
##     C_TSP_SAT + PUB_TSP, data = D_model2)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.7618 -0.2969  0.0066  0.2463  0.9003
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)      -0.516749   0.382965  -1.349    0.182
## ATT_SCAR          0.231038   0.045830   5.041 3.84e-06 ***
## CAR_VALUE_ALL     0.002078   0.056725   0.037    0.971
## recode_NUM_CAR>1 -0.136335   0.118669  -1.149    0.255
## C_TSP_SAT         0.036520   0.058653   0.623    0.536
## PUB_TSP           0.163526   0.099526   1.643    0.105
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3839 on 66 degrees of freedom
## Multiple R-squared:  0.4529, Adjusted R-squared:  0.4115
## F-statistic: 10.93 on 5 and 66 DF,  p-value: 1.1e-07
```

Conclusion: Attitude towards shared cars, Number of owned cars and Public transport usage (yes/No) are significant predictors for Intention of using Shared cars.

Stepwise regression

##DV = INTention to use Stad-up

```
D8 <- D4 %>%
  filter(INTENT_SU == "Yes" | INTENT_SU == "No") %>%
  mutate(recode_INTENT_SU = ifelse(INTENT_SU == "Yes", 1, 0))
```

```
D_model3 <- D8[c(69, 31, 5, 6, 9, 29, 67, 19, 68, 33)]

model_INTENT_SU <- regsubsets(recode_INTENT_SU ~., data = D_model3, nvmax
= 5,
                   = "seqrep")

summary(model_INT_SCAR2)
```

```
## Subset selection object
## Call: regsubsets.formula(recode_INT_SCAR2 ~ ., data = D_model2, nvmax =
5,
##     = "seqrep")
## 8 Variables  (and intercept)
##                 Forced in Forced out
## ATT_SCAR            FALSE      FALSE
## GEN_VALUE_1         FALSE      FALSE
## GEN_VALUE_2         FALSE      FALSE
## CAR_VALUE_DT        FALSE      FALSE
## C_TSP_SAT           FALSE      FALSE
## recode_NUM_CAR>1     FALSE      FALSE
## PUB_TSP             FALSE      FALSE
## CAR_VALUE_ALL        FALSE      FALSE
## 1 subsets of each size up to 5
## Selection Algorithm: 'sequential replacement'
##          ATT_SCAR GEN_VALUE_1 GEN_VALUE_2 CAR_VALUE_DT C_TSP_SAT
## 1  ( 1 ) "*"      " "         " "         " "          " "
## 2  ( 1 ) "*"      " "         " "         " "          " "
## 3  ( 1 ) "*"      " "         " "         " "          " "
## 4  ( 1 ) "*"      " "         " "         " "          "*"
## 5  ( 1 ) "*"      " "         " "         " "          "*"
##          recode_NUM_CAR>1 PUB_TSP CAR_VALUE_ALL
## 1  ( 1 ) " "              " "     " "
## 2  ( 1 ) "*"              " "     " "
## 3  ( 1 ) "*"              "*"     " "
## 4  ( 1 ) "*"              "*"     " "
## 5  ( 1 ) "*"              "*"     "*"
```

##Regression (to get the coefficient estimates) ## Removed GEN_VALUE_1, GEN_VALUE_2, CAR_VALUE_DT

```
M_3 <- lm(recode_INTENT_SU ~ ATT_SCAR + CAR_VALUE_ALL +
             recode_NUM_CAR + C_TSP_SAT + PUB_TSP + INT_SCAR2,
         data = D_model3)

summary(M_3)
```

```
##
## Call:
## lm(formula = recode_INTENT_SU ~ ATT_SCAR + CAR_VALUE_ALL +
recode_NUM_CAR +
##     C_TSP_SAT + PUB_TSP + INT_SCAR2, data = D_model3)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
```

```
## -0.83847 -0.27203 -0.02658  0.29860  0.99426
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)      0.77463    0.48480   1.598  0.11603
## ATT_SCAR         0.00321    0.07034   0.046  0.96377
## CAR_VALUE_ALL   -0.11500    0.06915  -1.663  0.10220
## recode_NUM_CAR>1 -0.08044    0.16068  -0.501  0.61869
## C_TSP_SAT       -0.04070    0.07488  -0.544  0.58900
## PUB_TSP          0.14444    0.12965   1.114  0.27027
## INT_SCAR2Yes     0.46866    0.15689   2.987  0.00426 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.439 on 53 degrees of freedom
##   (11 observations deleted due to missingness)
## Multiple R-squared:  0.3123, Adjusted R-squared:  0.2344
## F-statistic: 4.011 on 6 and 53 DF,  p-value: 0.002201
```

Conclusion: Attitude towards shared cars, and Car-related value (functionality-oriented) are (at leaast marginally) significant predictors for Intention of using Shared cars.

```
D3 <- D[,35:48]
D3[is.na(D3)] <- 0

D3$AVA <- D3$AVA0 + D3$AVA1
D3$PARK <- D3$PARK0 + D3$PARK1
D3$INSU <- D3$INSU0 + D3$INSU1
D3$KILOC <- D3$KILOC0 + D3$KILOC1
D3$SUBSC <- D3$SUBSC0 + D3$SUBSC1
D3$ACCESS<- D3$ACCESS0 + D3$ACCESS1
```