Personalising bicycle design to increase psychological ownership for rental services

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ABSTRACT
The notion of psychological ownership (PO) becomes more and more valuable for rental services to investigate. In cooperation with The Student Hotel, a study has been set up to investigate the role PO could have concerning the behaviour towards their bicycles. This study consists of a set of surveys and an intervention using a design prototype. These are presented in the following order: PO survey, pattern preference survey, intervention and a second PO survey. The PO surveys are compared in the analysis, while the pattern preference survey is used for personalisation of the intervention. After analysis of the results, a small, insignificant growth is visible in the feeling of personal PO, however, there is a significant decline in the feeling of shared PO. In conclusion, the results from this study show that using a personalised prototype can significantly influence the feeling of shared psychological ownership in the setting of a rental bicycle service.

AUTHOR KEYWORDS
Shared and personal psychological ownership, object attachment, personalisation, design research, experimental design, industrial design

INTRODUCTION
The 'sharing economy' is a trend that a growing number of researchers are exploring. Researchers are investigating the motivators of the users and the longevity of the phenomenon (Hawlitschek, Teubner & Gimpel, 2016; Hamari, Sjöklint & Ukkonen 2015; PRnewsreader, 2020; re:Jeruzalem, 2020). Bicycle rental services, such as the Dutch OV-fiets, the recognisable Swapfiets and the more local The Student Hotel bicycles, seem to be a part of this new sharing economy in the Netherlands. Due to this shift towards a sharing economy, it becomes more interesting to look at to what extent people feel these rented items are theirs. Research shows: when people feel ownership over an item, they tend to be extra careful and protective over said item (Hernandez 2012; Baer & Brown 2012). The notion of psychological ownership therefore becomes more and more valuable for rental services to investigate.

In this paper, a real-life scenario surrounding The Student Hotel (TSH) bicycle rental service in Eindhoven is studied. This study investigates if personalised designs can influence and possibly increase the feeling of psychological ownership, in the setting of rental bicycles. Specifically, rental bicycles for the long-staying students that live in the rooms of The Student Hotel. The service currently has significant problems with the rented bicycles breaking down quickly, which means that "they are not sustainable, they are expensive, and they have less user satisfaction." (Baxter, Aurisicchio & Childs, 2015)

Even though these designs are created specifically for The Student Hotel, the situation is socially impactful beyond this particular use case. The results of this research can, therefore, be interesting to all service-based companies out there and add to the currently growing pool of knowledge surrounding this subject. In this research paper, a study is described to aid in solving this problem. This small-scaled mixed methods study tries to answer the following question: Can personalisation achieve a higher feeling of psychological ownership (for rental bicycles)?

The structure of the paper is as follows: Firstly research into psychological ownership is presented and studies with a similar focus on ownership and personalisation are talked through. Second, the design of the inner-frame prototype served as the intervention and is further explained. Third, it is explained how the between group-experiments and surveys are conducted using this prototype. Fourth, the collected data and analysis of psychological ownership using the intervention are explained.

THEORETICAL BACKGROUND
The concept of psychological ownership is broadly applicable in different scenarios. It may show when talking about objects legally owned -my laptop-, shared -my place in the office-, or abstract -my idea-. Thus, psychological ownership is, in its simplest terms: the mental state in which individuals feel that the target of ownership is 'theirs' (Pierce, Kostova & Dirks, 2001). There is a direct link between psychological ownership and the feeling of attachment towards an object (Shu & Peck 2011). Having a sense of psychological ownership over an object also increases a person's perceived value of the object (Franke, Schreier & Kaiser 2010), and this makes them take better care of the object (Hernandez 2012; Baer and Brown 2012). The above thus shows creating a sense of psychological ownership over objects can be very important.

This feeling of ownership extends further than just the objects that are one's own, but can also be perceived in shared systems. This feeling of 'our' item, displays the collective feeling of psychological ownership (Verkuyten & Martinovic, 2017). Collective psychological ownership has already been studied in organisational settings. These studies looked at the different effects of employee ownership, which is the overall feeling of which employees feel like part of the company or how much it feels like 'their company'. These studies include Klein (1978) and Pierce, Rubenfeld & Morgan (1991), which look at predicting and understanding employee ownership and the resulting feelings and attitudes such as job satisfaction, commitment and job-related self-esteem.

In recent years, academics conducted more research on psychological ownership and design. Studies by Baxter et al. (2015) have provided designers with a framework that includes several affordances related to psychological ownership.

This framework helps understand these affordances and design for creating object attachment. These affordances are divided into three categories; control, self-investment and knowledge affordances. This study takes a closer look at the self-investment affordances, specifically those relating to personalisation, such as creation and emblems.

RELATED WORKS

There have been studies in the past that looked at measuring the level of psychological ownership towards a focused concept. Van Dyne et al. (2004) measured the feeling of ownership over an organisation in employees and linked this to their attitude in the workplace. To measure psychological ownership, they created a list of statements such as "this is MY (house)" to measure individual ownership and "this is OUR (house)" to measure shared ownership. Participants would answer to what extent they agree with these statements, and from those answers, psychological ownership could be measured. Paundra et al. (2017) used this same method to look at how levels of psychological ownership influenced a person their preference over a car rental service.

Regarding personalisation, there have been several studies on the effects of personalisation on the ownership of digital products. One study (Waltemate, Gall, Roth, Botsch and Latoschik, 2018) looked at the impact of digital avatar personalisation and found that the inclusion of personalisation increased the feeling of ownership over the avatars. Another study (Carrozzi et al., 2019), featured augmented reality holograms which could be customised by participants. This helped create a feeling of psychological ownership over the holograms, even in a shared setting (Carrozzi et al., 2019). Although the products concerned are digital, the outcome suggests that customisation or personalisation could work in a shared service.

PROTOTYPE DESIGN

To be able to answer our research question, a prototype was designed to personalise the bicycles from The Student Hotel to participants' preferences. Various ways of personalisation were considered, from more subtle through altering the bicycle's design, or more evident through the inclusion of a person's name. A brainstorm resulted in multiple prototype possibilities such as keychains, artefacts on the handlebars, stickers or decoration inside the frame of the bicycle. Since the design was supposed to fit an existing rental service bicycle, this study follows three main requirements. These requirements are as follows: The design had to be easily detachable, should not create a theft-threat and be aesthetically pleasing.
The decoration inside of the bicycle frame was ultimately chosen along with a focus on the bicycle's design, as it best suited the requirements of our research and was the most feasible given the short time frame. By letting participants fill in their pattern preferences, they will have a sense of self-investment into the bicycle aligning with the creation-affordance (Baxter et al., 2015). The design could also function as an emblem.

When designing the patterns of the frames, a distinction was made between organic and geometric patterns, as well as open and closed variants (figure 1). These were chosen based on research suggesting that people tend to prefer curved or natural shapes over abstract, sharp-angled ones (Gómez-Puerto, Munar & Nadal, 2016). Since this does not hold true for everyone,

abstract patterns were still included. The patterns were narrowed down to 6 designs, spread evenly across the graph (figure 2). The frames were painted black to suit the aesthetic of the student hotel bicycles. The prototype was mounted to the bicycle using cable ties, seen in figure 3.
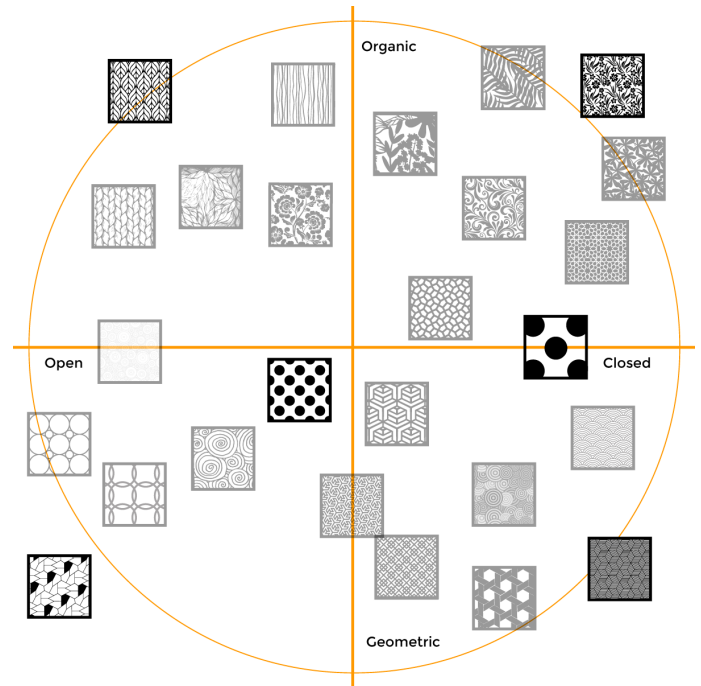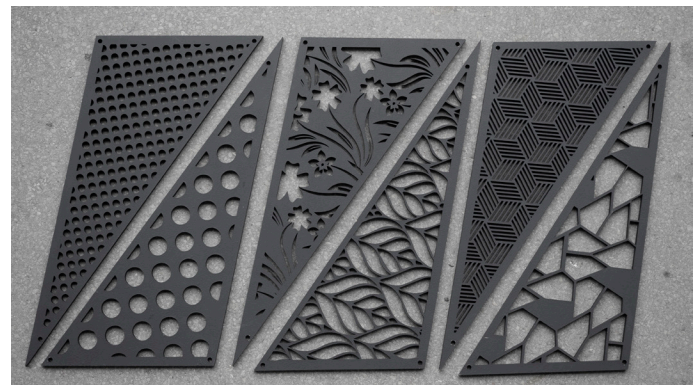

Figure 1: The different pattern options.

Figure 2: From left to right: circles, nature and abstract with the closed variant of the left and the open variant on the right.

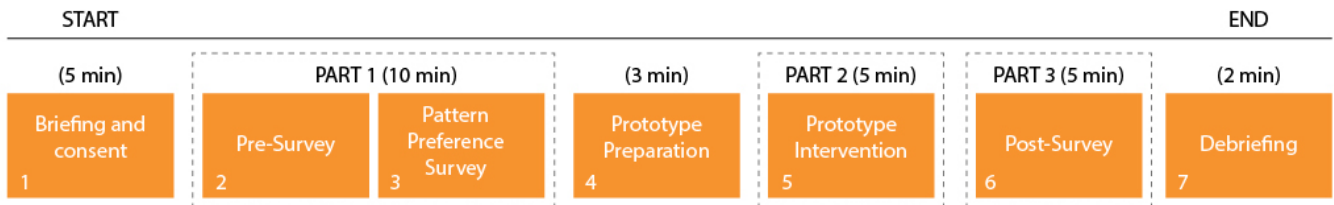*Figure 3: prototype within bicycle frame*

Figure 4: The timeline of contact with the participant during the experimental study.

METHODOLOGY

The study is conducted with 16 students living in Eindhoven, who all participated in the experiment for 20 to 30 minutes. The experimental study introduces the prototype, as described in chapter 'prototype design', to study the influence on psychological ownership. Personalisation is achieved during the experiment by switching the prototypes shown to the participant. The presented personalised prototype is based on preferences indicated in the pattern preference survey beforehand. Results between the pre- and post-survey will be used as the quantitative data for the analysis. In support of the quantitative data, qualitative data, in the form of notes and pictures is also gathered.

Experiment Design

For the design of the experiment, collecting quantitative data was leading. However, the study used a mixed-methods approach in which both quantitative and qualitative data was collected. The qualitative data was only used to investigate and support any outstanding findings in the quantitative data. The independent variable in the experiment was the personalisation of the prototype. The dependent variable was the preference for one of the two prototypes. The intervening variable was the role of the psychological ownership in this preference. Lastly, the antecedents were demographics, such as gender and age.

The experiments used a between-subject design with three groups. The test group (n=11) got shown two bicycles with similar-looking prototypes, of which one was personalised. The pilot group (n=1) used the same set-up as the test group. The control group (n=4) was presented with two bicycles without the intervention of the prototypes.

Participants

The researchers recruited most participants (n=11) through their social networks and that of The Student Hotel. Additional participants (n=5) were recruited via convenience sampling by asking people nearby the testing location at Eindhoven University of Technology. For each participant, there were three requirements: 1) The participant must be a student living in Eindhoven. 2) The participant must be able to attend the experiment physically in Eindhoven. 3) The participant must have experience with riding a bicycle.

Materials

Firstly, for the assessment and collection of data the materials used consisted of a laptop (or printed version) of all the surveys and consent forms. Secondly, for the prototype-intervention, during the test, the materials were as follows: two bicycles, design prototypes. The two bicycles were provided by The Student Hotel and thus were identical in appearance, apart from the occasional usage marks and scratches. The prototypes used showed different patterns, as described during the design chapter. Thirdly, additional materials used include paper, cable ties, scissors, a camera, a list of participant IDs and a printed

version of the experiment procedure. Furthermore, disinfectant and face masks were used by the researchers to adhere to the COVID-19 measures.

Procedure

The study, in terms of data collection, consists of a set of surveys beforehand (part 1), a prototype intervention (part 2) and a post-survey (part 3) afterwards. Quantitative data is only gathered during these indicated parts in Image 4: timeline. During part 2 (the prototype intervention) also qualitative data, such as observations, are collected.

The pre-survey is mainly used to gather demographic data and set a baseline for the feeling of psychological ownership. The pre-survey contains demographic questions (section 2.1), a scenario sketch (section 2.2) and a measurement of psychological ownership (section 2.3). For this measurement (section 2.3) the participant answers statements with a 5-point Likert scale. This part of the survey is based on a set of statements that were used by Van Dyne et al. (2004) to determine the feeling of shared and personal ownership. The post-survey contains the same scenario sketch from section 2.2 and the same statements about psychological ownership from survey section 2.3. In addition, the post-survey contains a new section 5.3 with additional questions on possible influential factors that contribute to their choice of bicycle.

The participant continued with the pattern preference survey, directly after the pre-survey. In this pattern preference survey, the participant was presented with six sets of patterns in a random order, out of which the participant chose a favourite within each set (see Image 5: example question). These patterns were not the same as the ones featured in our prototype but had the same themes. Since each theme out of the list, circles, nature or abstract, was paired with the other themes, a favourite could be concluded. This favourite will then be used in the prototype intervention, together with the non-favourite pattern. The non-favourite pattern was randomly chosen between the two remaining themes. However, from the patterns shown during the prototype intervention, one pattern was always 'open' and the other pattern always 'closed'.

The prototype-intervention is the moment during the study in which the participant interacts with the prototype. This physical interaction is used to ensure people can touch and feel the bicycles. The importance of this tangible connection is based on the spatial and temporal control elements, as mentioned in the Baxter model (2015). The participants were asked to view and inspect the bicycles, then pick the one they liked the most. During this choosing process, they were asked to think out loud, or in other ways, explain what they were thinking and what influenced their decision-making. After choosing, they were allowed to ride the bicycle for a maximum of five minutes, after which they were invited back to fill in the final post-survey.

3

Which pattern do you prefer? *

○ Pattern 1   ○ Pattern 2

Figure 5: Example Question from the pattern preference survey. The pattern on the left is nature-themed, and the pattern on the left shows a geometric theme.

DATA AND ANALYSIS
Analysis

The data collected during the tests can be divided into three categories: demographic data, the feeling of personalisation and the data for psychological ownership. The demographic data is collected in order to discover if the participants of The Student Hotel had a correlation with the participants that do not live at The Student Hotel. The analysis for the psychological ownership was performed with a combination of data from both the pre- and post-survey. The analysis of these results is further explained in the rest of the 'Data and Analysis' chapter.

Quantitative Data Findings
Demographics

Demographic data were used to analyse the influence of the antecedent variables. There was no statistically significant difference between different demographic groups, as determined by one-way ANOVA analysis. This analysis was conducted for gender and age. Furthermore, there was no statistically significant difference in any of the answers between residents of The Student Hotel and non-residents as determined by one-way ANOVA.

For all participants who joined the study through social networks there was a time-gap between filling in the pre-survey and performing the rest of the test. Four participants firstly joined the study on-site, which made that they did not have this time-gap. A one-way ANOVA analysis determined that there is no statistically significant difference between this group and the convenience sampling group on any of the tested variables.

Personalisation

To test whether the participants had a different feeling of personalisation between the test and control group, an analysis of this expected difference was conducted. There was a statistically significant difference between the test and control group with regards to the presented designs as described below. There was a significant difference in the influence of aesthetics of the bicycles as determined by one-way ANOVA ($F(1,13)$ = 6.228, p = .027). Additionally, there was a significant difference in the feeling of receiving a personalised bicycle as determined by one-way ANOVA ($F(1,13)$ = 25.436, p = .000).

Psychological Ownership

For the following analysis, 2 of 10 participants from the test group were left out because they did not ride the bicycle that matched their predicted aesthetic preference. Because of this,

their data could not be used for this analysis since their feeling of psychological ownership was affected by riding a bicycle that did not match their aesthetic preference. Therefore, the test group in this analysis consisted of 8 participants and the control group of 4 participants.

To discover the differences between the pre- and post-survey, the researchers used a paired samples t-test. A paired samples t-test is used to discover if an intervention had an effect. There are 36 recorded instances for the feeling of 'MY bicycle'; and 27 recorded instances about 'OUR bicycle'. The psychological feeling for 'MY bicycle' as a means starts before the experiment at 2.39 on a scale of 1 till 5. The feeling for 'OUR bicycle' is stronger, with a mean of 3.78.

The after personalisation results show a small increase (0.03) in the 'MY bicycle' category, rising the mean to 2.42. A more noticeable change appeared within the 'OUR bicycle' category, with a decrease of 0.63, ending the mean of our bicycle at 3.15. The standard error is reasonably low, reaching highest at 'MY bicycle' with 0.13 and lowest at 'OUR bicycle' with 0.10. The correlation (Mine 0.711 and our 0.556) between the pre- and post-survey of the test group shows that both the mine and our are significantly positively correlated. The significance of the test is proven to be more trustworthy within the feeling of 'OUR bicycle' with a significance reading of 0.004 (0.4%). Contradicting the results of our bicycle, the significance reading of my bicycle was 0.860 (86%).

Paired Samples Statistics

	Mean	N	Std. Deviation	Std. Error Mean
Pair 1 Mine_Before	2.39	36	1.103	.184
Mine_After	2.42	36	1.317	.220
Pair 2 Ours_Before	3.78	27	0.973	.187
Ours_After	3.15	27	1.199	.231

Paired Samples Test

	Paired 95% Confidence Interval of the Upper	t	df	Sig. (2-tailed)
Pair 1 Mine_Before Mine_After	.291	-.177	35	.860
Pair 2 Ours_Before Ours_After	1.042	3.136	26	.004

Figure 6: The results of the Paired samples T-Test

For the control group, there was, similar to the test group, a small increase (0.06) in the 'MY bicycle' category, raising the mean from 2.31 to 2.38. The total feeling of 'OUR bicycle' increased with 0.67 for the control group, raising the mean from 3.00 to 3.25. There was, however, no statistically significant difference between the test and control group on an increase or decrease of the feeling of personal and shared ownership for 6 out of 7 tested assets of ownership. Only the feeling of 'OURS' as a The Student Hotel community did have a statistically significant difference between the test and control group as determined by one-way ANOVA ($F(1,11)$ = 7.587, p = .019).
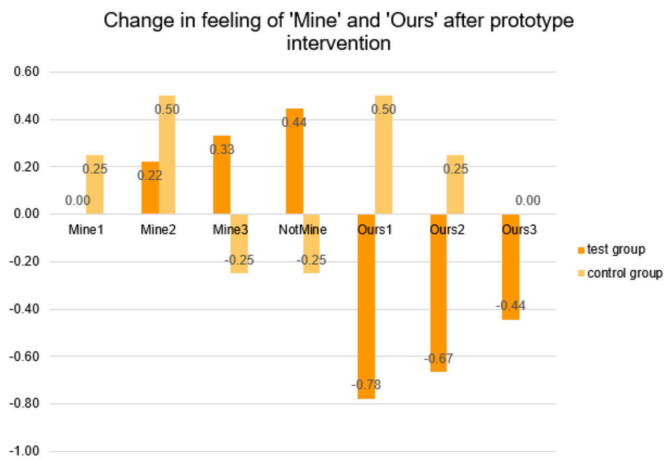
Figure 7: Visual representation for the differences in the control and test group

Qualitative Data Findings

Although the main focus of the analysis of the quantitative data gathered, the qualitative data can offer some insights into the thought process and understanding of the participants. Since it concerns unstructured interviews and observations, the qualitative data gathered can not be generalised beyond the sample group.

Most people that chose their personalised pattern indicated that they clearly identified the difference in patterns between the two bicycles. Only one participant clearly identified the pattern as 'his', while the other participants simply noted an aesthetic preference. This shows the apparent role of the design in the decision-making process.

For the two participants who did not choose their personalised bicycle, the notes and observations clearly indicate they ultimately oversaw the designed frames. These participants instead focused entirely on the quality of the bicycle alone, for example, in terms of scratches and tire strength. However, in the experiment design, it was made sure the bicycles were almost identical in settings. Therefore both participants noted being indifferent about their choice and only when being asked to choose again they both picked the 'non-personalised' bicycle.

During the test with the control group, two participants mentioned choosing the bicycle due to more convenient placement within the experiment location. The participants noted that the bicycle they chose was placed slightly in front of the other, which in turn allowed the participant to manoeuvre it more easily before starting the small round of cycling.

Lastly, one participant mentioned that the given scenario was not exactly clear to them. If this was the case for more participants, this might have influenced the answers given. However, as shown in the qualitative data analysis, no statistical difference was found between the TSH-residents and the rest of the participants.

DISCUSSION
Study size
Due to the limited responses from residents of The Student Hotel, the situation surrounding the COVID-19 pandemic and the limited time for the project, we only managed to test with 16 participants. This limited the results and our ability to indicate how our personalised design would influence the psychological ownership of the bicycle service of The Student Hotel. More participants would generate better and more reliable results.

Personalisation
Due to the statistical difference between test and control group regarding a feeling of personalisation, it can be concluded that the intervention prototype did appear to be personalised to the test subjects enough for testing our hypothesis. Future research could look into other types of design personalisation and their effect.

Influence of demographic background
Due to no statistically significant difference in different demographics, it can be concluded that demographics did not play a role in the feeling of personal and shared ownership for this study. The same would hold for being a TSH resident or not. However, this study was limited to only testing with two TSH residents. Since this number is so low, it cannot for sure be said that being a resident was not of any influence. Further studies on the difference between users and non-users are needed to conclude this.

Additionally, the largest part of the participant group was unfamiliar with the exact context. They were provided with a textual scenario sketch, but we cannot be sure if this was enough. The feedback given about the clarity of the scenario shows that some of our participants were not familiar enough with the service, for accurately indicating their feeling of ownership. For future studies, it is necessary to test with users that are more familiar with a shared bicycle service, and preferably also a frequent user of a shared bicycle service.

Psychological ownership
It is interesting to see that there was no significant difference between test and control groups, with regards to the decrease or increase of the feeling of personal ownership. Even though they felt a significantly different feeling of personalisation, this mainly did not reflect on the feeling of personal ownership. The feeling of shared ownership did, however, show a significant difference between the test and control group. Whilst the test group had a decreased feeling of shared ownership after the test, the control group had an increased feeling of shared ownership. If it were because the bicycle felt more personal than before, we should have seen this reflected in personal ownership. Therefore we are unsure why this is the case, and recommend further qualitative studies on the reasoning behind this change in feeling.

Other remarks
Participants in the control group commented on choosing a bicycle, not because of the frame design, but because it happened to be the bicycle in front of them or in better condition. If these subjects chose their most favourable design, it might have been a result of this condition or position instead of the actual aesthetic. It is suspected that the placement of the bicycles played no role during the testing with the testing group. Since no participants in the testing group noted this similar feeling and most did identify the difference in designs as the primary motivator. For future studies, more attention should be paid to ruling out the influence of these possible variables of condition and placement.

CONCLUSION

Our research question was as follows: Can personalisation achieve a higher feeling of psychological ownership (for rental bicycles)?

There can be conclusions drawn over the fact that a personalised item does indeed influence the feeling of psychological ownership. However, due to the limited number of participants, this research merely shows an indication. In this study, the participants' feeling of personal ownership was not significantly influenced, but the feeling of shared ownership was significantly lowered due to the intervention of our experimental prototype.

The contribution of our study to the field of psychological ownership and shared services is that we found that personalised design intervention lowers the feeling of shared ownership. Other findings of this study provide starting points for future studies. Future research could look into other types of personalisation to see how a larger feeling of personal ownership could also be reached. Furthermore, similar research should be repeated with more participants.

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APPENDIX

Appendix 1: Background Researchers

In line with our skills and learning goals we have determined for each person main responsibilities throughout the project, one of which is chosen for their skills and interests, the other by their learning goals. By doing this, everyone will have an opportunity to learn something new from another team member who has more experience in that aspect of the research project.

Researcher 1
Jurrien Brondijk
Main Role   Background research & Prototype Design

Through design, interesting discoveries are often made. However, these discoveries are rarely published. Though we can learn from some successful designs, many products fail and their teachings get lost. This is why I find research through design important. By publishing findings we progress in both the design and research fields.
I often gravitate towards lab research because it allows me to focus on my design without any environmental hindrances, though I think a research method should be picked to best suit the research being done.

I always try to ground my designs within research, but fail to do a thorough literature study in order to do so. This project I wanted to do a more in-depth background research, which is partly why I took this up as one of my main roles.

I also aimed to learn how a prototype could be made for a research purpose, so I took charge in the designing of the prototype and making sure it was suited for testing.

Researcher 2
Kelly Fransen
Main Role: Statistics & analysis, dataset, survey

I believe that research is the best way for laying foundations for meaningful design. During my design projects I want to follow a research-based approach, where I want to make design decisions based on available prior research. During the DCM100 course I wanted to learn more on how to apply proper research methods, and contribute to a research field. Through appropriately using acknowledged design and psychology studies, I am hoping to assure quality and meaning within all my projects. Furthermore, I wanted to further train my SPSS skill, to be able to provide a statistical data analyses that we can draw conclusions from.

As a preparation on the study, I did some research on how to measure personal and shared ownership. I set up a survey for testing the different type of ownership, based on two previous similar studies.

I took on the role of working on the statistical analysis together with Sander, because I could apply my knowledge from SPSS again here and could further develop myself in this program.

Additionally, I prepared the quantitative data from all tests for the analysis. Whilst doing this, I could learn about the different analysis methods in both Excel and SPSS and the decisions to make there.

Researcher 3
Hannah van Iterson
Main Role: Methodology

Doing research for design is something I have focussed on during my bachelor, and only recently have I started thinking more about research through design.

Due to this, I have gained some knowledge in doing field research, but often specifically for the design that I was working on. I feel comfortable going into the field and asking people there for feedback.
However, I know I lack structure when doing actual research. Where talking to people and doing interviews is not an issue for me, working with just qualitative data does not always bring out the most conclusive results.

Even though I had originally picked field research to deepen by knowledge, I am happy I ended up in a lab group. Here, I have gotten the responsibility to work on the methodology. This included setting up a test, preparing for it and creating an exact organization. As I had identified this as a learning point for myself, I was happy to work on this skill during this course.

Researcher 4
Sander Pouw
Main Role   Prototype & statistics

Before Industrial design, I spent my time designing for a very broad range of different questions. Ranging from a new lightswitch to creating a new marketing plan. All with a user-centered approach, in other words, user-testing became second nature. While this variety was very much appreciated, it was hard to develop a focus on one particular target. After graduating Communication and Multimedia Design I started the pre-master Industrial design at TU/e.

During this project, my main goal was to learn more about the analysis of data. Something that wasn't covered very broad within my bachelors. It was pleasant to be able to share this task with Kelly, discussing multiple approaches and techniques helped me a lot to understand the subject.

Researcher 5
Chantal Vriens
Main Role: Methodology & participant gathering

Before starting my Industrial Design master, I got my bachelor degree in Creative Technology from the University of Twente. Before starting my Master's, I went on an exchange abroad and became an active member of a student team that supports the future of hydrogen cars. As a designer, I prefer to take a role that allows for critical reflection and a proactive attitude. Throughout my design, I like to focus on meaningful human interaction and the connecting between the user and the design.

Within this course, I wanted to choose a methodology that allows me to explore this critical role further and allows you to make an objectively meaningful claim. I think the laboratory approach fits this role well since it requires structure and critically thinking ahead. You should have a clear plan and order for the variables to remain consistent. My primary role is my responsibility for the methodology, which fits my vision well. In the methodology, you design the user interaction with the prototype, and it really allows me to explore the laboratory approach by setting up the experiment design..