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DESIGN FOR MEANING IN PRODUCTS AND SERVICES TO FOSTER ECO-SUFFICIENT USER BEHAVIOR: EXEMPLIFIED BY SHARING GOODS

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Abstract

The goal of this thesis is to support designers in harnessing the meaning users should find in products and services, in order to foster eco-sufficient user behavior. Despite its importance in sociology for explaining consumption, the concept of meaning is empirically underexplored in design research. Meaning was defined as mental representation of possible relationships of which products and services can be a part.

Literature studies identified two promising analytical avenues into meaning: its underlying structure for relating meaning to design, and its role in cognition for linking meaning and behavior. The analysis of meaning's structure was theoretically grounded in Peirce's triadic model of signs. This model describes meaning starting from its inference. Thus, inferences were the vantage point for analyzing meaning. A further literature study into the relation between meaning making and behavior resulted in the Meaning-Behavior Model. The prospects were that both analytical avenues, the triadic model of signs, and inferences allow the researcher to analyze and describe the successfully conveyance of meaning and the relation of meaning to behavior in a more detailed way and by that highlight new means how designers can design for meaning.

In order to empirically explore meaning, a design-as-communication perspective was taken. Designers, users and non-users of six different services, related to bicycle and washing machine sharing, were interviewed. The meanings they had found in these services were qualitatively analyzed and compared through statistical tests. The inter-rater reliability (Krippendorff's alpha) for different steps of the qualitative analysis was between 0.571 and 1. The conceptualization of meaning had never been used in an empirical study in design and consumer research before. Therefore, a coding scheme was developed for various determinants of meaning, such as the meaning's structure called MOSC-entities, reference of these entities to aspects of services visualized in the MeaningMap, the valence, and the level of congruence between meanings.

The empirical study showed how designers can facilitate the successful conveyance of their intended meanings, support the acceptance of services, and improve the communicative potential of services. For example, by making use of causal relationships between entities of intended meanings, designers can facilitate their successful conveyance. Regarding the influence of meaning on user behavior, it was shown that potential users must make their own efforts in meaning making to adopt a service. However, various ways were discussed how designers can support potential users in their efforts. For example, designers can anticipate comparisons to alternative solutions. Sustainability, and eco-sufficiency in particular, only played a secondary role in meanings users and non-users found in the studied services. Primarily, the adoption of a service was characterized by meanings based on personal gains.

The empirical findings were synthesized into several supports, which can take the form of predictions, hypotheses, use cases, guidelines, recommendations, and a sequence for reasoning. They support designers in one of the following ends: successfully conveying meaning; designing against undesired meanings; designing for improving the communicative potential of services; design for meaning to foster eco-sufficient behavior. Finally, the meaning-based design approach was discussed from the perspective of existing concepts in literature and ultimately considered as a distinct but inclusive perspective on design.

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Chapter 1 Introduction

1.1 Motivation

Humanity has to cope more than ever with numerous environmental challenges, as it has overstepped three out of nine interlinked planetary boundaries by destabilizing the "Earth-system processes" of climate change, biodiversity loss, and the nitrogen cycle, and may soon exceed the boundaries for global freshwater use, change in land use, and ocean acidification as well (Rockström et al., 2009). These challenges are caused by the dominant lifestyle and consumer behavior, mainly in developed countries (DESA, 2013), but affect the whole world.

Without doubt, companies need to contribute to these challenges, as they rely on stable Earth-system processes for managing the associated risks (Whiteman et al., 2013). For sustainable development, i.e. staying within the boundaries of Earth's capacity to sustain human action, Huber (1995, 2000) distinguishes three strategies:

- Efficiency: "applying principles of input-output rationalization";
- consistency: an "environmentally compatible nature of industrial material flows and energy use"; and
- sufficiency: the voluntary self-limitation of resource needs, such as fossil fuel, land, and other finite resources (Linz, 2015).

As Reichel et al. (2009) argue, sufficiency seems at first sight "contradictory to existing techno-economic rationalities" based on growth, and therefore is the most difficult strategy to pursue. However, they further argue that sufficiency can also lead to competitive advantages by reorganizing production and consumption. At its core, the sufficiency strategy is about influencing use patterns and user behavior (Reichel et al., 2009). Elsewhere, Reichel (2013) specifies that companies need to develop products and services, which support users in eco-sufficient lifestyles, and relieve them from "material burdens" and supply them with more time; in short: increasing well-being by consuming less.

For instance, developing and deploying bike-sharing systems can allow bike-producing companies to leave behind "existing techno-economic rationalities" of selling more and more bikes, but instead adopt a product-service system business model and get paid for every bike rented out. Such bike-sharing systems reorganize production and consumption by integrating users into the service delivery process and by defining sharing as the mode of consumption. At the same time, users are relieved from the "material burdens" of owning a bike, such as maintenance, by voluntarily changing their use patterns towards sharing.

Jackson (2008) reflects on the question, whether it is possible to increase well-being by consuming less, from various theoretical views:

- eco-humanism sees consumer societies "in the grip of a social pathology" stemming from their "insatiability of wants" and social norms;
- evolutionary views emphasize the "evolved nature of consumer behavior", which offers "selective advantages" for example through social status;

- "the consumption-as-meaning school" highlights the "symbolic nature of goods", i.e. the role goods play in people's pursuit of meaning, the construction of personal identities and the formation of cultures.

He concludes that only the "consumption-as-meaning school" raises hopes that it is possible to "live better by consuming less" by devising other and more sustainable ways for pursuing personal and cultural meaning.

For discussing the role of designers in sustainable consumption, Thorpe (2010) compares three research areas: environmental policy, psychology, and sociology. The latter comes closest to what Jackson means with 'consumption-as-meaning school' and is therefore further described. Thorpe summarizes that sociological research on consumption sees consumer society and material goods as human's "dominant meaning structure", which is maintained by commerce. She argues that designers need to explore alternatives to the dominant meaning structure and proposes to consider the nonprofit and public sectors for seeking those alternatives outside of commerce.

It is concluded that due to its prominence in describing consumption, and especially sustainable consumption, the concept of 'meaning' lends itself to be considered during designing products and services. The importance of meaning is supported by cultural psychology, in which humans are seen as meaning seekers, who have an actual need for meaning (Heine et al., 2006) and actively seek meaning instead of only constructing it (Wong, 2014). The concept of 'meaning' also yields hopes to explain how behavioral change can be sustained.

The required change in use patterns for eco-sufficiency and the symbolic nature of goods raise several guiding questions for designers. For example, when coming back to the bike-sharing system: does the system allow its users to construct personal identities around it? Does the system need to go beyond dominant meaning structures of commerce? How should the bike-sharing system be seen: as part of an eco-sufficient lifestyle, or another lifestyle? How does the bike-sharing need to be organized so that it refers to the intended lifestyle and personal identities: fully automated, as a public service, or based on a community?

First attempts have been made to discuss more sustainable strategies for pursuing meaning on the level of product and service design. For example, Scholl (2006) explored differences in symbolic meanings of possessions and services from a theoretical perspective, and developed recommendations for service designers and marketers on how service users can regain a sense of control and identify with the service. However, as Scholl (2006) highlights, there is much more to explore regarding the role of meaning in design and in sustainable consumption patterns, in order to increase well-being by consuming less material resources.

1.2 Research aim and main research questions

This research aims at supporting designers in harnessing the role of meaning in products and services, in order to foster eco-sufficient user behavior. The previous section indicates that meaning is an important concept to explain consumption, i.e. user behavior with regards to products and services, however much exploratory work is needed to fully grasp its potential. In addition to describing how users make meaning, the link between meaning and behavior needs to be explored. Designers need to know what meaning users find in products and services to know if their intended meaning got across successfully and whether there are differences between users and non-users. Moreover, it is essential for designers to know how they can address meaning. It is also necessary to define the concept itself: meaning is an abstract concept, which is

often used uncritically in design research by equating it with other concepts such as experience (Vyas and van der Veer, 2006), function (Hormuth, 1999; Steg, 2005), and affordance (Kroes and Franssen, 2015).

Sociology and psychology, however, have developed a considerable body of knowledge. In this thesis, theories of both fields are considered that use the concept of 'meaning' for explaining behavior. With this background knowledge, approaches and topics in design that use of the concept of 'meaning' are investigated. An empirical exploration into meanings in products and services has been undertaken yielding deep insights into the actual role of meaning. In the thesis, the constructivist research paradigm is followed, which essentially assumes that no single truth exists, but truths need to be constructed from interpreting reality.

Marketing and branding also play an important role in product meaning (Mick et al., 2004). These areas fall outside the scope of this research, but are mentioned when other authors refer to them, or when it seems appropriate.

As the title of the thesis reveals, the focus is on services, which involve sharing goods as one of many types of eco-sufficient user behavior.

From the above, the research aim is translated into the following first set of research questions:

1. How is meaning made by users, and how is it related to user behavior?
2. What meanings are conveyed to users and non-users through products and services?
3. How do meanings made by users and by non-users differ to explain their behaviors?
4. How can meaning be addressed by designers, and how can they best be supported?

1.3 Structure of thesis

This thesis follows the DRM design research methodology by Blessing and Chakrabarti (2009). It consists of four stages called Research Clarification (RC), Descriptive Study I (DS-I), Prescriptive Study (PS) and Descriptive Study II (DS-II). The RC stage aims at concretizing the research aim and the way to its achievement. Its results have led to the used research paradigm, a first research direction, and a set of research questions. In the DS-I stage a deeper understanding of the research field is sought, in this thesis by analyzing literature (Chapter 2 and Chapter 3) and executing an empirical study with designers, users and non-users (Chapter 4). With the obtained knowledge, a support is developed for designers to harness the role of meaning in their designs (PS stage described in Chapter 6). Due to time limitations, no evaluation of the support was possible (DS-II stage), however the implications of the developed support on design theory are discussed in Chapter 7.

Table 1 provides an overview of the structure of the thesis by integrating the DRM stages, and the first set of research questions (RQs).

Table 1: Structure of thesis

Main chapters	*DRM stages*	*RQs*	*Description of chapters*	*Results relating to other chapters*
2: Meaning	RC & DS-I		Literature studies into meaning and into its use in design and design for sustainable behavior	Research paradigm, refined RQs & identification of underexplored areas: -> used in Chapter 4

Main chapters	*DRM stages*	*RQs*	*Description of chapters*	*Results relating to other chapters*
3: The relation of meaning and behavior	DS-I	1	A literature study into the role of meaning in cognition and its relation to behavior.	The Meaning-Behavior Model: -> used in Chapter 4 to inform data analysis & in Chapter 6 to derive design recommendations
4: Characteristics of the empirical study	DS-I	2; 3	The description of the studied service examples, the entailed use behavior, and the empirical study.	Operationalization of meaning for the empirical study; Research tools MOSC-entities and MeaningMap -> used in Chapter 5
5: Empirical findings	DS-I	2; 3	Quantitative and qualitative results sorted by research questions and common themes	-> used in Chapter 6 by linking findings to design
6: Design for Meaning	PS	4	Discussion of design for meaning from the perspective of the design theory by Roozenburg & Eekels. Application possibilities of the empirical findings.	Predictions, hypotheses, guidelines, recommendations, and a sequence for reasoning
7: Discussion and conclusion			Comparison of the concept 'meaning' to other concepts in design. Linking the research results to design for sustainable behavior.	

Chapter 2 Theoretical and methodological background

In this chapter, the concept of meaning in semiotics (Section 2.1), in design (Section 2.2) and in design for sustainable behavior (Section 2.3) are discussed. Two analytical avenues into meaning are pursued, and the results of a literature study into existing approaches and topics covering meaning are discussed, in order to identify underexplored areas, to position the followed approach in literature, and to refine the research questions.[1]

At the end of this chapter (Section 2.4), the following guiding questions are answered: How can meaning be described? How is the concept of meaning used in design literature, specifically about design for sustainable behavior?

2.1 Meaning

Many philosophical theories of meaning exist that are especially lively discussed in linguistics. Naming and comparing these here would go beyond the scope of this thesis. Philosophical theories are prescriptive by nature, and consist of beliefs, principles, and laws (Lacey, 1996) about how to conceive meaning, which must not necessarily spring from empiricism. Thus, such theories are philosophical positions which cannot be tested such as scientific theories but require the acceptance by the researcher.

In essence, theories of meaning (as discussed e.g. by Anolli, 2005; Hughes, 1999; Nagasaka, 2007; Osgood, 1952; Speaks, 2017) conceive meaning through its use; its function; its role in cognition; its reference; its truth; its verification in use; and its structure. These philosophical positions are partially complementary and can be combined, as proposed by Anolli (2005) and open up analytical avenues into meaning.

According to Baumeister's (1991) investigations into meanings of life, meaning can be defined as "shared mental representations of possible relationships […]". Baumeister did not restrict the use of this definition to meanings of life, and emphasized that for example the meaning of a sentence can be defined in a similar way: the meaning's parts are fitting "into a coherent pattern"; it is "capable of being understood by others"; it fits into a "broader context"; and is based on "implicit assumptions" shared by others (Baumeister, 1991). Therefore, I assume that the above definition can also be transferred to meanings, which people find in products and services. Additionally, I assume that there is no fundamental difference between meanings of products and meanings of services.

Baumeister's definition implies that meaning can be deconstructed into parts of a coherent pattern, i.e. structure. I assume that design research can benefit most from the concept of meaning, when its structure is unveiled and analyzed, in order to account for more informative detail.

[1] Some parts of the sections about semiotics, design as communication, and methods have already been published in Waltersdorfer et al. (2015a, 2017).

2.1.1 Semiotic theories

Semiotic theories can provide structural ways particularly useful to analyze meaning. Semiotics is concerned with signs (Chandler, 2007). According to Peirce (CP 2.228)[2] a sign is "something which stands to somebody for something in some respect or capacity".

Sign models

Two primary sign models were developed independently from each other at about the same time by Saussure, a linguist, and Peirce, a logician: While Saussure advanced a dyadic, or two-part, description of signs, Peirce argued for a triadic version.

According to Saussure (1959), a sign, as "a two-sided psychological entity", is composed of a "signifier", which is a sense impression, and a "signified", also called concept or meaning. Both elements recall each other during the process of signification and are therefore united through association (ibid.) (see Figure 1).

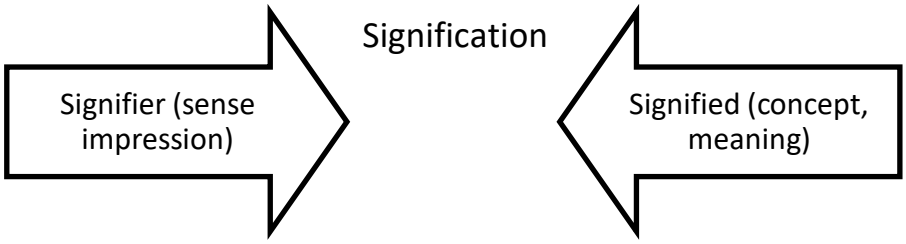

Figure 1: Saussure's dyadic sign model

In Peirce's (CP 1.339) triadic model (see Figure 2), "[a] sign[3] stands for something to the idea which it produces, or modifies. […] That for which it stands is called its object; that which it conveys, its meaning; and the idea to which it gives rise, its interpretant." Peirce (CP 1.372) described the interpretant as "[..] cognition produced in the mind". Thus, Peirce's model consists of three entities: sign, object, and interpretant. In the following, the more familiar term 'concept', as proposed by Sowa (2000) is used instead of Peirce's term 'interpretant'. The dashed arrow between sign and object indicates that these entities are not related directly, but only through the concept.

[2] References to Peirce are abbreviated by 'CP', which stands for his "collected papers" edited after his death. These papers are indexed by volume and paragraph numbers.

[3] As Atkin (2013) points out, Peirce's notion of sign is confusing, since the overall structure and one of its entities are called sign. Elsewhere, Peirce calls the entity the sign-vehicle. Atkin proposes to call the entity „signifying element of a sign". However, in order to keep things simple, in this thesis it is referred to this entity as ‚sign', and the overall structure as triadic model of sign.

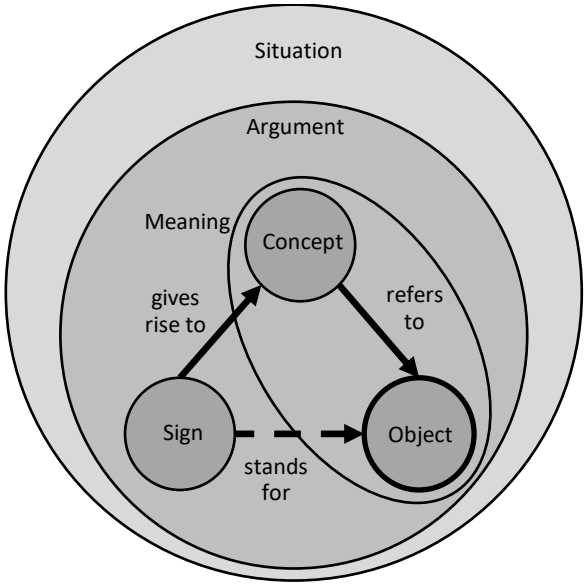

Figure 2: Peirce's triadic sign model (meaning triangle)

For example, following Saussure's model, a bike-sharing system, i.e. the signifier, could mean freedom, i.e. the signified. In Peirce's tradition, the bike-sharing system as a sign perceived by its user, gives rise to the idea of freedom, i.e. the concept. Both sign and concept refer to the user as object. The sign only stands for the user through the idea of freedom. Any other aspect of the bike-sharing system, such as its on-demand availability, can act as sign.

Comparison of the sign models

Both models provide accounts for representation, i.e. the description of something that stands for something else, and for signification, which is according to Chandler (2007), the process of establishing the relations or references involved in meaning. However, Peirce explains signification in more detail by highlighting the role of inferential interpretation: as he (CP 2.308) noted: "nothing is a sign unless it is interpreted as a sign", i.e. signs come to existence through interpretation[4]. He (CP 5.253) also holds the reverse: "[..] that every thought is a sign", and further specifies (CP 5.307) that "the association of ideas consists in this, that a judgment occasions another judgment, of which it is the sign. Now this is nothing less nor more than inference." Therefore, signs are a referential way to conceptualize interpretation based on inference (Peirce and Hoopes, 1991). Moreover, Peirce's model can also be used to describe communication, which is the conveyance of thoughts through signs. As Danesi (2004) summarizes, signification is concerned with meaning making by individuals, and communication is concerned with conveyance or negotiation of meaning.

When further comparing the two models by Saussure and Peirce, Chandler (2007, p. 18ff) emphasizes that Saussure's conception of meaning gives primacy to relations, whereas in Peirce's model, meaning is conceived of its references. He further states that Saussure's "signifier" and Peirce's "sign" are similar, and the "signified" is comparable to the combination of "concept" and "object". Chandler also (2007) points out a special feature of the concept, which cannot be found in Saussure's model: as Peirce (CP 2.303) mentions, "[a]nything which determines something else [its concept] to refer to an object to which itself refers [its object] in the same way, the interpretant [i.e. concept] becoming in turn a sign, and so on ad infinitum." Thus, the concept can become itself a sign, and therefore "[a]ny initial interpretation can be reinterpreted"

[4] Throughout the thesis, interpretation is conceived as a process, but never as its result, which is meaning.

(Chandler, 2007). In other words, the triadic model can be stacked. For example, the idea of freedom as concept, evoked by the bike-sharing system as sign, can also become a sign and in turn give rise to another concept, such as the liberation of all townsmen.

Based on this comparison, it is concluded that Peirce's model is preferable for describing the structure of meaning for informing design practice by deconstructing it into three entities (sign, object, concept) for the following reasons:

- it accounts for a higher granularity through its triadic nature compared to the dyadic model by Saussure;
- it allows the researcher to describe inferential cognitive processing through interpretation and re-interpretation.

The argument and Peirce's phenomenological categories

Elsewhere, Peirce (CP 1.559) describes a special type of sign, the argument, by using familiar terms from logic: "[i]n an argument, the premisses form a representation of the conclusion, because they indicate the interpretant [i.e. concept] of the argument, or representation representing it, to represent its object. The premisses may afford a likeness, index, or symbol[5] of the conclusion." This quote highlights several interesting thoughts:

1. in logic, arguments consist of premises and conclusions;
2. premises are signs, since they form representations of conclusions;
3. when comparing the quote to the process of signification, it seems that signification can also describe making inferences as moving from premises to conclusions, which results in equating the conclusion of an argument with meaning;
4. the quote specifies that premises and conclusions can be linked through likeness, index or symbol.

I take up the first three thoughts when discussing the operationalization of meaning in Section 4.3.3. The fourth thought requires some elaboration. Likeness, index, or symbol are grounded in Peirce's three universal phenomenological categories: "quality", "fact", and "law" (CP 1.418ff), categories which he applied in his reasoning about signs (cf. CP 1.558):

- Likeness refers to the relation between sign and concept, which is based on their **similar** qualities.
- Index denotes a physical or **causal** relation based on facts.
- Symbol refers to a relationship based on a law-like **convention**, which "must be agreed upon and learned" (Chandler, 2007).

I call these categories in more indicative terms "similarity", "causality", and "convention". They form the basis of relation between sign and concept. For example, the relation between the bike-sharing system as sign and freedom as concept is based on convention, since the relation is questionable and needs to be agreed upon.

Meaning and context

Anderson (1933) states in Saussure's dyadic tradition that an "inequality of interest" exists between two associated ideas. The less interesting entity is the signifier; the more interesting entity is the thing being

[5] It might confuse the reader, versed in semiotics, how an argument, as a special type of symbol, can afford a different type of sign. Peirce (CP 1.473) explains it through the concept of "degeneration": triads can also describe dyadic or monadic relations. He illustrates the degeneration with the following example: "[…] oranges and lemons smell alike, though it is properly only a dyad, yet may be considered as a triad, the common quality of smell being the third subject."

signified[6]. For example, a ring on a person's left hand is a sign for being married: the marriage is more important than the ring and the hand. This "inequality of interest" creates a tension, which differentiates meaning from context (Anderson 1933).

"Context is the frame of mind […] invoked to characterise an entity" (Shahare and Gurumoorthy, 2007). In some simple models of communication, context is only used to explain misunderstanding or ambiguity (Doyle, 2007). However, as Doyle further argues, there are no context-free meanings, because of "human presence as an integral part of the context". Seen from semiotics (Sebeok, 2001), "[t]he context is the environment – physical, psychological, and social – in which a sign […] is used or occurs." The situation is the relevant part of a larger context and includes the "immediate circumstances" of signification.

2.1.2 Data collection methods for capturing meaning

In this section, a brief overview of data collection methods for capturing meanings is provided to be able to compare empirical studies based on the applied methods and to discuss whether these methods can be combined with Peirce's triadic model of signs.

Methods for capturing meanings mainly originate from psychology. They are applied in design research as well as market research, but to different ends. These methods can follow a quantitative approach for measuring "the degree in which phenomena occur", a qualitative approach for investigating "the nature of phenomena", or a combination of both as mixed method (Blessing and Chakrabarti, 2009). The applicability of the methods depends foremost on the assumptions behind one's research paradigm, such as positivism or constructivism[7], the conceptualization of meaning, the research question and the unit of analysis. Depending on the chosen data collection method and research paradigm, the deconstruction of captured meanings requires different analysis methods.

Meaning can be easily captured quantitatively, when it is conceptualized in predetermined categories. For example, Joseph-Mathews et al. (2009) determined how utilitarian, hedonic, and novelty meanings of leisure facilities mediate the relationship between the service environments of these facilities and the behavioral outcomes of their visitors. They captured the meanings visitors find in the leisure facilities through structured interviews. As another example, Allen and Ng (1999) analyzed the impact of human values on consumer choices depending on symbolic and utilitarian meanings of automobiles and sunglasses. The meanings were captures through a questionnaire.

The Semantic Differential (SD) method of Osgood (1952) is a widely used quantitative method in design research. He notes that the captured meanings through the SD are only connotations and not denotations, and that they can be considered as the point in the semantic space, which is established by a list of polar terms, and in which participants allocate the concept of interest. For example, the SD was applied in a study into design-as-communication by Khalaj and Pedgley (2014) for comparing intended and reconstructed meanings, in order to determine the extent and areas of (in)congruent meanings.

Similar to the SD, the repertory grid (RG) by Kelly (1955) measures meaning by asking participants to position the object of interest on a scale between several bipolar semantic dimensions (in Osgood's terms) or constructs (in Kelly's terms). For SD, the dipoles are defined by the researcher. For the RG, they are elicited

[6] In his terms: symbol and symbolized. In order to avoid confusion, they are renamed to signifier and signified. Since, as mentioned before, the signified can be equated with a combination of Peirce's interpretant and object, Anderson's thoughts can be easily transferred to the triadic model.

[7] These are the two predominant paradigms in social sciences (Hudson and Ozanne, 1988)

from the participants in a qualitative approach, which makes the RG a mixed method. Both methods, SD and RG can be conceived as a variation of Saussure's dyadic model of signs: the object of interest, for example a product, is the signifier, which is related to the signified, i.e. the dipoles. The variation is that in both methods there is a whole list of bipolar scales as "the signified". Thus, both models only determine the signifier's position in the semantic space, and its actual meaning. For example, Fallman and Waterworth (2010) used the RG in a study to capture dimensions of meaning that people ascribe to electronic devices after experiencing different styles of human-computer interaction embodied in these devices. The involved scales in both methods can be filled either in a questionnaire or during an interview.

Another mixed method, is called "measure of consumption object meaning" (MOCOM) (Kleine and Kernan, 1988), which allows researchers to measure denotative meanings of products through continued one-word associations elicited from participants by asking "[w]hat is the object? and [h]ow do you think the object will be used?" For example, it was tested how the context in advertisements influences the ascription of meaning to products in an experimental research design (Kleine and Kernan, 1991).

Qualitative research approaches have a long tradition in consumer research for comprehending meaning holistically (Levy, 2005). For researching inferred meanings, Graeff and Olson (1994) recommend personal interviews, since they allow researchers to ask clarifying questions. Interviews have high potential for gaining deep insights into meanings if they are underpinned by interviewing techniques such as laddering, probing and deflection: The laddering technique involves repetitively asking "why"-questions to proceed from the product or service attributes to meaning and user's values (Reynolds and Gutman, 1988). Probing, as recommended by Mick (1986), aims at stimulating the interviewee to provide more information by various strategies such as remaining silent or paraphrasing (Bernard, 2006). Heffner (2007) reported that deflection, i.e. asking in a way that interviewees need to immerge into a third person, was especially useful for capturing symbolic meanings.

In sum, for quantitative data collection methods, only the semantic differential and the repertory grid are suitable for analyzing the structure of meaning. However, both data collection methods follow Saussure's dyadic sign model. No quantitative data collection method was found, which can be combined with Peirce's triadic model of signs. In contrast, interviews, as a qualitative method, allow the researcher much flexibility to capture meaning. It is envisioned that interviewing techniques can help to verbalize the inferential cognitive processing behind meaning making, and that these inferences can be analyzed through Peirce's triadic model.

2.2 Meaning in design

Since Krippendorff's (1989) famous proposition "form follows meaning", meaning in products and services has received increased attention in design research. In the following, different approaches are discussed to highlight how meaning is addressed in design research literature and to identify underexplored areas of the application of 'meaning' in design in general, in design as communication, and in design for behavioral change.

2.2.1 Design approaches and topics

In this section, design approaches and topics are compared, which explicitly or implicitly through related concepts, make use of the concept 'meaning'. Table 2 summarizes these approaches and topics in design. The approaches and topics are distinguished by several dimensions (columns of the table), whose values

were compiled in a data-driven manner. To avoid a vast number of categories, some values of the dimensions are specified in brackets.

- The **role of meaning**: the concept of meaning is either central to the investigations into the design approach and topic or ancillary in order to inform or support another central concept.
- The **area of application** specifies the design approaches and topics by naming the design research areas in which meaning is applied.
- The **purpose of the application** roughly distinguishes the end to which the concept of meaning in design approaches or topics is applied: whether meaning is applied to improve design, or to finally influence user behavior (as is the focus of this dissertation).
- **Underlying theories** of meaning indicate how 'meaning' is conceived by the authors of the references. These theories inform the analytical avenue that is taken about meaning.
- The **type of investigations** into meaning are divided into theoretical, empirical, or both. Additionally, it is specified, if the investigation was a case study, and whether the investigation covered the designer and/or the user side of communication through a product or service.

The table is sorted first by the 'purpose of application' and second by the 'area of application'. I will refer to Table 2 on three occasions: 1) in this section for discussing the table as a whole; 2) for discussing products as a communicative medium in more detail in Section 2.2.2; and 3) for discussing approaches and topics for the purpose of 'influencing user behavior' in more detail in Section 2.3.

Table 2: Overview of approaches or topics in design, which include the concept of 'meaning'.

Name of approach or topic (reference)[8]	***Dimensions***				
	Role of meaning	***Area of application***	***Purpose of application***	***Underlying theories***	***Type of investigation***
Design as interpretation (Glock, 2003, 2008)	Ancillary, explicit	Describing the design process	Improving design	Not reported	Both
'Types of embodiment' (van Rompay and Ludden, 2015)	Ancillary, explicit	Specifying product experiences	Improving design	Embodied cognition, Semiotics (dyadic)	Theoretical
Design for Emotional Durability (Chapman, 2009)	Ancillary, explicit	Explaining user's attachment to product	Improving design (framework)	Not reported	Both
Product-user relations (Battarbee and Mattelmäki, 2002)	Central	Making categorizations of products	Improving design	Not reported	Empirical
Product semantics (Butter, 1989; Krippendorff, 2006)	Central	Informing design theory	Improving design	Wittgenstein: meaning in use	Both
Design requirements (Nagasaka, 2007)	Central	Informing design theory	Improving design	Dummett (meaning and its verification)	Theoretical
Framework of product experience (Desmet and Hekkert, 2007)	Central	Specifying product experiences	Improving design	Appraisal theory	theoretical (one case: introspection)
Designing for resonance (Su and Liang, 2013)	Central (meaning-making)	Explaining product experience	Improving design (design process)	Borgmann (meaning and cognition)	Both (case study)
Experience as meaning (Vyas and van der Veer, 2006)	Central (experience)	Product experience (during interaction)	Improving design	Not reported, but inspired by theory of art	Both (case study)

[8] When the authors did not provide a name for the approach or topic, I introduced a 'term' (emphasized by 'single quotation marks')

Name of approach or topic (reference)[8]	***Dimensions***				
	Role of meaning	***Area of application***	***Purpose of application***	***Underlying theories***	***Type of investigation***
Products as representations (Vihma, 1995)	Ancillary, explicit	Explaining Interpretation	Improving design	Semiotics (triadic)	Both (cases interpreted by author)
Design semiotics (Kawama, 1987)	Ancillary, implicit (inference)	Informing the design process	Improving design	Semiotics (codes)	Both (cases interpreted by author)
Designing for the self (Zimmerman, 2009)	Ancillary, explicit	User's attachment (meaning making)	Improving design	Not reported	Both
Product attachment (Casais et al., 2015; Mugge et al., 2010)	Ancillary, explicit	Explaining user's attachment to product	Improving design	Consumer research	Both
'Commodities as signs' (Nöth, 1988)	Central	Categorization of commodities	Improving design	Semiotics (i.a. Barthes)	Both (one case interpreted by author)
Critical interpretation of objects (Boradkar, 2006, 2010)	Central	Reflecting on the social and cultural role of products	Improving design	Semiotics (sign reading; triad), STS	Both (cases interpreted by author)
'symbolic interactions as inspirations' (Lai, 2014)	Ancillary, explicit	Describing user interaction	Improving design (sources of inspiration)	symbolic interactionism	Both (case studies, designer side)
'multiple interpretations' (Sengers and Gaver, 2006)	Central	Meaning-making in user interaction (Human-computer)	Improving design (shift from meaning transfer to intervention)	Humanist theories; SCOT	Both (case study, designer and users)
Product architecture (Hu et al., 2013)	Ancillary, explicit	Human-product interaction	Improving design	Not reported	Both (observation, case study)
Semiotic interface design (Nadin, 1988)	Ancillary, explicit	(conceptualizing) Products as communicative medium	Improving design	Semiotics (triadic)	Theoretical (in this reference)
'Symbolic meaning in product evaluation' (van Rompay et al., 2009)	Central (symbolic meaning)	Products as communicative medium (stimulus congruence)	Improving design (principles)	Visual perception	Empirical (user side)
Capturing users' perception of experiences (Nurkka et al., 2009)	Central	Products as communicative medium (user experience)	Improving design (analytical tool)	Dewey (meaning in use)	Both (user side)
Semiotics of buildings and products (Krampen, 1989)	Central	Products as communicative medium	Improving design	Semiotics (dyadic, affordance)	Both (user side)
Emotional responses to products (Demirbilek and Sener, 2003)	Ancillary, explicit	Products as communicative medium	Improving design	Product semantics	Both (observation)
'Retention of meaning through visual appearance of a product' (Khalaj and Pedgley, 2014)	Central	Products as communicative medium (product impression)	Improving design	Semiotics (mentioned triad, applied dyad)	Both (designer and user side; quantitative)
Kansei Engineering (Keitsch and Hiort Af Ornäs, 2008; Nagamachi, 1995)	Ancillary, implicit (communic.)	Products as communicative medium	Improving design	Semantic differential (dyadic)	Both (quantitative)

Name of approach or topic (reference)[8]	***Dimensions***				
	Role of meaning	***Area of application***	***Purpose of application***	***Underlying theories***	***Type of investigation***
Product language (Steffen, 1997, 2009)	Central	Products as communicative medium	Improving design	Susanne Langer (meaning in use)	Both (cases interpreted by author)
Semiotic engineering (Sjöström and Goldkuhl, 2005; de Souza, 2005; de Souza and Barbosa, 2006)	Central	Products as communicative medium (HCI)	Improving design	Semiotics; Speech-act theory	Both (cases interpreted by author)
Product character: intention and perception (Ahmed and Boelskifte, 2006)	Ancillary, implicit (communic.)	Products as communicative medium	Improving design	Semantic differential (dyadic)	Empirical (designer and user side; quantitative)
Product appearance attributes (Blijlevens et al., 2009; Creusen and Schoormans, 2005)	Ancillary, explicit	Products as communicative medium	Improving design	Product semantics	Both (user side)
Meaning structure modeling (Georgiev, 2008; Georgiev et al., 2008)	Central (concept)	Products as communicative medium (Design method)	Improving design	Psycholinguistic theories of human lexical memory (concept map)	Both (evaluation study, designer side)
'Designing products for enduring meaning' (Walker, 2010)	Central	Extending triple bottom line	Influencing user behavior (sustainable)	Not reported	Theoretical
Product development and responsible consumption (Marchand and Walker, 2008)	Ancillary, implicit (attachment)	User's attachment to product (close and distant)	Influencing user behavior (voluntary simplicity)	Not reported	Both
Symbolic meaning of services (Scholl, 2006)	Central	Servitization	Influencing user behavior (sustainable)	Consumer research	Theoretical
Consumption as social practice (Scott et al., 2012)	Ancillary, explicit	User interaction (meaning as part of practices)	Influencing user behavior (sustainable)	Practice theories	Both
'scripting, appropriation, practice' (Ingram et al., 2007)	Ancillary, explicit	Products as communicative medium	Influencing user behavior	Practice theories; STS	Theoretical
The role of the user (Frissen and van Lieshout, 2006)	Ancillary, explicit (categories)	Products as communicative medium	Influencing user behavior (acceptance)	Sociology (domestication)	Both (case study)
Formal approach to sustainable design (Feijs and Meinel, 2005)	Central	Products as communicative medium (codes)	Influencing user behavior	Semiotics (codes); Meaning in use	Both (case study: designer side)
'cultural codes' (Santamaria et al., 2016)	Central (symbolic features)	Products as communicative medium (codes)	Influencing user behavior (sustainable)	Semiotics (codes)	Theoretical
Cultural and ideological views on sustainability (Santamaria et al., 2015)	Central	Products as communicative medium	Influencing user behavior	Semiotics (Greimasian square)	Both (observations in mass media texts, design side)
'moralizing technology' (Jelsma, 2003, 2006)	Ancillary, implicit (communic.)	Products as communicative medium (script)	Influencing user behavior (eco-friendly)	Semiotics (script)	Both (observation, pilot study, design side)

Name of approach or topic (reference)[8]	*Dimensions*				
	Role of meaning	***Area of application***	***Purpose of application***	***Underlying theories***	***Type of investigation***
Images and car purchases (Heffner, 2007)	Central	Products as communicative medium	Influencing user behavior (car purchases)	Semiotics (dyadic)	Both (user side, qualitative)
'Challenging current design maxims' (Helfenstein, 2012)	Central (3 categories)	Products as communicative medium	Influencing user behavior (consumer preference)	Consumer research	Both (user side)
Design with Intent (Lockton, 2013)	Ancillary, explicit	Products as communicative medium	Influencing user behavior	Product semantics, Gestalt psychology	Both
Significance of things (Hiort Af Ornäs, 2010)	Central (significance)	Products as communicative medium	i.a. influencing user behavior	Personal construct theory	Both (triangulation)
Product semantics for Eco-efficiency (Chakraborty, 2012)	Central	Products as communicative medium	Influencing user behavior (sustainable)	Product semantics (Meaning in use)	Both (research through design)

Legend:
SCOT: social construction of technology
STS: science and technology studies
HCI: human-computer interaction

In total, Table 2 lists 45 approaches and topics. 30 of them focus on 'improving design' in general. The remaining 15 approaches and topics focus on 'influencing user behavior'. In 25 out of 45, meaning plays a central role, in the 20 remaining, meaning is only ancillary to one of the two purposes. Eleven not mutually exclusive categories are defined in a data-driven way, for the research areas in which the concept of meaning is applied (**area of application**):

- Products as communicative medium: Products and services carry an intended meaning by their designers and are interpreted by their users, and thus convey meaning as a medium (Crilly, Maier, et al., 2008). 23 approaches and topics are assigned to this category. For nine of them meaning is only ancillary, since for example, the focus is on emotional responses by users, or on product appearance.
- User-product interaction: Four approaches and topics fall into this category. In one of them meaning plays a central role by describing the interaction with products through the meaning-making process of users. In the remaining approaches and topics, meaning is only ancillary to describing the symbolic interactions as design inspirations, to product architecture, and to consumption as social practice.
- Product experience: This category covers four approaches and topics in design, which explain or specify experiences that go beyond the actual user interaction. Meaning is central to three of those approaches and topics.
- User attachment: Four approaches and topics have been found in the research literature, which use meaning as one way to explain users' attachment to products. By that the role of meaning is ancillary.
- Making categorizations: in two approaches and topics meaning is central to making categorizations of commodities and product-user relations.
- Informing design theory: two approaches and topics are found in which meaning is used to inform design theory. For both, meaning plays a central role.
- Design process: Meaning is also applied in two approaches and topics to inform or describe the design process.
- There are four areas of application to which only one approach or topic applied: symbolic meanings of servitized products (Scholl, 2006); extending the triple bottom line of sustainable development by

the dimension of personal meaning (Walker, 2010); reflecting on the social and cultural role of products through their meanings (Boradkar, 2006, 2010); explaining interpretation (Vihma, 1995).

This list highlights the vast variety of application areas, in which meaning is addressed. Further analysis of the table is needed in terms of the underlying theories and types of investigations to identify promising but underexplored research areas.

Regarding the **underlying theories** behind meaning, eight approaches and topics do not report any. Five scholars explicitly refer to philosophers as Borgmann, Dewey, Dummett, Langer and Wittgenstein. For example, Wittgenstein conceived meaning through its use, which is, as mentioned in Section 2.1, one analytical avenue into meaning. Krippendorff (1989) based his ideas in product semantics on Wittgenstein. By that, he differentiates four contexts of product usage, in which products can mean different things: the operational context, i.e. artifacts in use; the sociolinguistic context, i.e. artifacts used in communication; the context of genesis, i.e. artifacts created and used in the organization of culture; and finally, the ecological context, i.e. artifacts used in relation to each other. Four additional approaches and topics in Table 2 refer to Krippendorff's product semantics.

However, as argued in Section 2.1, the preferred analytical avenue in this thesis is into the structure of meaning, for which semiotic theories are well suited. Semiotic theories are mentioned 13 times as the underlying theory and thus the most commonly used. Four of them use Peirce's triadic model of signs, two use Saussure's dyadic model, and the rest other semiotic concepts such as scripts and codes, which are discussed in Section 2.3.2. A look into the type of investigation of these approaches and topics is needed to further specify promising research areas.

For eight approaches and topics, the **type of investigation** is only theoretical, for three it is empirical, and for the remaining 34 approaches and topics, both, a theoretical and empirical investigation is pursued. From the four approaches and topics, which apply Peirce's triadic model, and which are thus most relevant to this thesis, two make investigations in a way that is unsuitable for answering the second research question about what meanings are conveyed to users and non-users: in these references (Vihma, 1995) (Boradkar, 2006, 2010), the authors act as experts for the application of their theoretical constructs and interpret the covered cases by themselves instead of capturing the meanings which users find in products. The third triadic approach or topic, whose author is Nadin (1988), is about interface design, in which meaning's role is only ancillary. The fourth triadic approach, covering the work by Khalaj and Pedgley (2014), requires special attention, because of its similarities to this thesis: meaning plays a central role in their investigations about both sides of the communication process through products as a medium. The differences are that the authors introduce the triadic model but finally apply a dyadic model to deconstructing meaning in a quantitative approach, and that they aim at improving design rather than specifically influencing user behavior.

It can be concluded from discussing Table 2 that there is an underexplored combination of dimensions of approaches and topics in design, which include the concept of meaning: using meaning as the central concept, analyzing it through Peirce's triadic model of signs, as underlying theory, and empirically investigating the meanings which users and non-users find, instead of interpreting product and service examples by myself. As mentioned before, the triadic model is preferred, since it accounts for more informative details. However, despite this gap, some references can be used for describing design-as-communication in Section 2.2.2 and determinants of meaning in Section 2.2.3.

2.2.2 Design-as-communication

Regarding the conveyance of meaning, as it is addressed by the second research question, the design-as-communication approach seems suitable to shed some light on it. In design-as-communication, the process of communication can be described in the following way: the designers' intention is conveyed (or transferred) through the product and perceived and interpreted by the user, who may give a cognitive, affective and/or behavioral response (Crilly et al., 2004; Crilly, Good, et al., 2008; Crilly, Maier, et al., 2008). Conceiving this process from the perspective of meaning, the designer forms and creates an intended meaning about the product or its users, which is conveyed to a user or non-user through the product, who in turn reconstructs the same or another meaning in a given context (Figure 3).

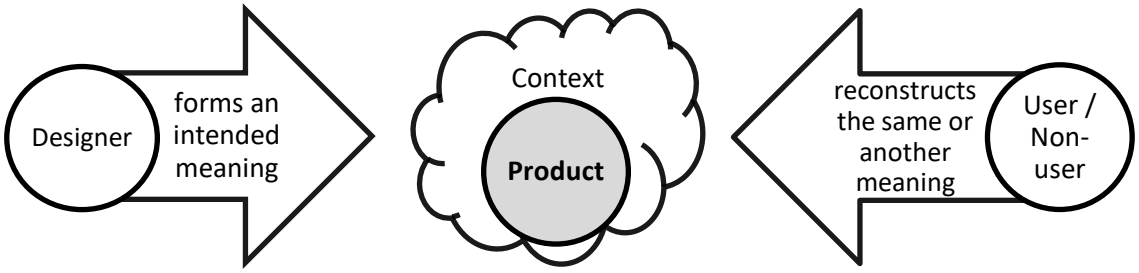

Figure 3: Process of meaning conveyance

Crilly et al. (2008) identified five complementary perspectives on the communicative potential of products and services: they can be considered as a language; as part of sign systems; as instruments of persuasion; as components of social interaction; and as message or medium of the communication process. In this thesis, two perspectives are covered: products and services as part of sign systems, and as medium in the communication process. The theoretical focus of this thesis on semiotics, i.e. the study of signs, does not only facilitate the deconstruction of meaning (see Section 2.1.1), but also the description of products and services as parts of sign systems during communication.

"Products as communicative medium" is one category in Table 2: 23 out of 45 approaches and topics apply meaning in this area, which is thus the most commonly used area of application. Semiotics is the underlying theory in ten out of these 23 approaches and topics. Only two approaches and topics investigate both sides of the communication process: the designer and the user. By that, a direct comparison for determining the successful conveyance of meaning is possible.

Krippendorff (Krippendorff, 1990, 2006) notes that designers need to anticipate reconstructed meanings by users, and thus need to get an understanding of users' understanding, i.e. a second-order understanding. The successful conveyance is further complicated since products and services only have limited communicative potential, and since users and non-users are most often not involved in design and need to learn by trying out or observing others (Krippendorff, 2009). All these factors highlight the difficulty of creating meaning that is reconstructed as intended.

> *For example, while designing a laptop, the designers intend to convey high quality (intended meaning) by choosing a unibody aluminum casing rather than a plastic casing. The user could perceive this solution indeed as high quality (correctly reconstructed meaning) or as less sustainable due to its energy-intense and wasteful production (incorrect reconstruction, yet a possible meaning).*

Interest of consumer research in meaning, represented by three references in Table 2, lies naturally on the following aspects of meaning transfer: the consumer as receiver, the message, the context of the transfer,

and media for transferring a message in addition to the product or service (McCracken, 1986; Mick et al., 2004; Oswald and Mick, 2006; Puntoni et al., 2010). Contrarily, interest of design-as-communication research focusses primarily on successfully conveying meaning through the product or service itself (Kazmierczak, 2003), and on influencing user's interpretation by means of design (Crilly, Good, et al., 2008). However, it depends on the users, which meanings they reconstruct and whether these were the intended meanings. Besides the respective products and services, the reconstruction is also influenced by, for example, personal experiences and preferences, the context, the users' peers, marketers, and culture (Desmet and Hekkert, 2007). Crilly, Good et al. (2008) further argue by referring to art theory that users rely on making "inference of what designers intended". Thus, next to interpreting a product on its own, users can immerse themselves in the role of the designers to understand the product. Therefore, design research needs to take inferred intentions by users into account.

It is stipulated here, inspired by the tenet of social construction of technology to always give symmetrical accounts of acceptance and rejection of technology (Pinch and Bijker, 1984), that interpretations by non-users should be of interest for design-as-communication as well. The importance of non-users was also recognized by Wyatt (2003, 2014). The same product or service can have different meanings, as these are not technologically determined, but created and cultivated by different social groups (Bijker, 2009). In case of conflicting meanings, controversy can arise between social groups, such as designers, users and, non-users. It is through a process of social construction that meanings in products and services converge (ibid.). I will refer to these ideas in the general discussion in Chapter 7.

Coming back to semiotics, as a means for deconstructing meaning and describing products and services as parts of sign systems, the roles that products and services can play in sign systems need to be clarified. Scholars, listed in Table 2, who worked with Peirce's triadic model of sign (see Section 2.1.1), assumed that products and services always take the role of the sign[9]. Contrarily, as it was first discussed using contrived examples (Waltersdorfer et al., 2015a), it is assumed that products and services can additionally take the role of the 'object', 'concept', and 'part of situation' in the triadic sign model. A further exploration of this concept is still needed.

It can be concluded from this section, that first, semiotics is one approach to study design-as-communication, which rarely covered both the designer and the user side of the communication process; second, it is important to study inferred intentions by users; third, users as well as non-users need to be involved in the investigation; and fourth, products and services can play more roles than only the sign.

2.2.3 Determinants of meaning

Scholars in design research agree that meaning can be considered as mental relations (Krippendorff, 1989; Vihma, 2009). In this section, determinants of relations are described, which in turn are determinants of meaning, and which can inform empirical investigations:

- Social agreement: this determinant answers for whom the established relations are valid. Depending on the level of agreement, one can distinguish between personal (Heskett, 2002) and socially shared meanings (Kleine and Kernan, 1988).
- Valence of meaning: pleasant or unpleasant thoughts, events or objects involved in the relations determine if the meaning in a product or service is considered positive or negative (for example see:

[9] Based on this assumption, a scientific dispute arose between advocates of design semiotics and design semantics on the utility of the 'sign' for design research and practice (Krippendorff, 1998; Vihma, 2007).

(Heffner, 2007)). The valence is traditionally conceptualized as a bipolar determinant (Desmet and Hekkert, 2007). However, a qualitative approach allows the researcher to cover the additional values: neutral valence and ambivalence.

- Ways of inquiry: this determinant concerns the contexts in which users and non-users are engaged with a product or service for establishing mental relations as meaning. I adapted Krippendorff and Butter's (2007) three ways in which researchers, in this thesis users and non-users, can inquire about meaning: observing, interfacing, and anticipating. Users (and non-users) can 'observe' others using their artifacts; they can 'interface' with the artifact; and they can 'anticipate' relations by uncovering contexts of use from narratives of artifacts (Krippendorff and Butter, 2007).
- Sign and concept and their basis of relation (see meaning triangle in Section 2.1.1): both can be considered as determinants of meaning, since they specify mental relations by answering what is how related.

It depends on the methods used for capturing meanings if these determinants of relations can be taken into account in empirical studies. So far, no empirical study covered the two latter determinants of meaning (see Section 2.2.1).

2.3 Meaning in design for sustainable behavior

First of all, the following assumption of this thesis needs to be highlighted: linking meaning to behavior requires a different analytical avenue into meaning than linking meaning to design. In Section 2.1, I argued that meaning in design is best explored by analyzing its underlying structure. Here, I assume that meaning and user behavior are best linked through analyzing the role of meaning in user cognition as this may provide possible explanations of how meaning and behavior are related. The two analytical avenues complement each other to inform design for behavioral change through meaning.

Table 2 shows that only 15 out of 45 approaches and topics applied meaning to influence user behavior. Eight out of these 15 specifically focus on sustainable behavior. For example, Walker (2010) argued to extend the triple bottom line of sustainability (Elkington, 1997) – balancing social, environmental, and economic goals – by personal meaning, and subsequently explored ways of making products personally meaningful. Eleven out of 15 approaches and topics applied meaning to the conceptualization of products as communicative medium. In 9 of 15 cases, meaning also plays a central role, however, in 3 cases the focus was on subareas of meaning: symbolic features of products; significance of things, leaving out comprehensibility; and preconceived categories of meaning. None of the empirical studies found covered both sides of the communication process, i.e. the designer and the user side, in order to explore how user behavior can be influenced. Table 2 highlights two sets of theories, which underlie the use of meaning in design to foster behavioral change: social practice theories, and semiotics. Both are discussed in detail in Sections 2.3.1 and 2.3.2.

In addition to directly explaining user behavior, the concept of meaning is also used to describe the acceptance of products and services, as a preliminary stage towards adoption. According to Miceli and Castelfranchi (2001), acceptance is defined as a positive attitude towards something. Frissen and van Lieshout (2006) emphasize the role of meaning in products and services when discussing the acceptance of information and communication technology: the place of technology in everyday life is decided through a "struggle over meaning", i.e. between intended use and actual use, both in a functional and symbolic way. Piscicelli et al. (2015) add that personal values can be "proxies for meaning", and contribute to the acceptance of sustainable practices.

2.3.1 From the perspective of social practice theories

According to Reckwitz (2002), practices can be the foundation of cultural theories next to mental structures, texts, and social interactions. He conceives practices as "routinized bodily activities". Such activities are: carried and carried out by agents; socially reproduced; based on social structure and shared understanding; and formed by interpretation. Interestingly, Reckwitz ascribes the use of sign systems to all potential foundations of cultural theories: unconscious symbolic systems in mentalism; texts as sign systems in textualism; interactions as signs in intersubjectivism; and practices or involved objects becoming signs (Reckwitz, 2002). Warde (2005) argues that practice theories can give an account of routinization by describing the reproduction of activities. By considering the consumption or use of any product or service as practice, it is hoped that scholars can "move beyond symbolically oriented theories of consumption" (Shove and Pantzar, 2005). Ingram et al. (2007) conclude about the implications of conceptualizing consumption through practice theories on product development that practice theories demand to pay attention to the "coevolving relation between human and nonhuman actors (objects) […] in the process of 'doing'".

In practice theories the concept of meaning seems only be used ancillary and analyzed from how it is used 'in the process of doing' and contained in shared understanding and interpretations. Thus, in practice theories, meaning is conceived through its use, i.e. as results of interpretation, but not its actual role in cognition, i.e. to explain interpretation, which is the targeted analytical avenue into meaning. Despite this limitation, practice theories are still beneficial to meaning-based design for sustainable behavior, due to their conceptual breadth.

2.3.2 From the perspective of semiotics

Semiotics plays a main role in this research. In this section the semiotic concepts 'codes' and 'scripts' are discussed and linked to design for sustainable behavior.

Codes are used in semiotics to describe the process of communication, and the regulation of behavior: senders encode their intended meanings into a message containing a set of signs, from which, after being transferred through a medium, recipients decode the same or another meaning. The only requirement is that the rules for coding are known to both parties, as stated by Coupland and Jaworski (2001). They further mention that non-linguistic representations also involve codes: for example, socio-cultural norms such as dress codes and etiquettes, rule how one should behave. According to Feijs and Meinel (2005), codes used in industrial design are e.g. color, form, material, texture, and user behavior. Ultimately, codes link the expression and content planes of messages (Feijs and Meinel, 2005). Mick et al. (2004) summarize applications of codes in consumer research, for example to categorize consumer responses based on the three codes: logical, aesthetic, and social; but conclude that more "code-cracking" is required by scholars. Santamaria et al. (2016) focus on the conventional aspects of cultural codes, when discussing how sustainable products and services can reach mainstream audiences, and propose some methods for market research, such as code mapping.

When reflecting on codes from the analytical avenues into meaning, it seems that codes are used to describe cognition, for example during encoding and decoding in communication, but do not contribute to describing the conveyance of meaning in communication, as the role of meaning in cognition is capable of. This is supported by Sperber and Wilson (1987), who argue that the concept of 'codes' is limited to describing human communication, because it requires mutual knowledge and symmetrical operations from the communicators. Instead, they advocate the concept of 'inference': senders use signs, which they assume are relevant to recipients in order to prompt the recipient to make the right inferences. In an inferential process,

premises are taken as input, which yield a conclusion as output in a logical form (Sperber and Wilson, 1987). Anolli (2005) argues that Sperber and Wilson's relevance theory is especially worthwhile, since it does not break down with miscommunication.

A **script** is, according to Pettersen (2009), "the framework designers inscribe into a product or system, indicating that technologies to some extent can prescribe the actions of users by inviting some behaviours and counteracting others". The concept was introduced to science and technology studies by Akrich and Latour (1992) to describe the "semiotics of human and non-human assemblies" and subsequently taken up by several design researchers (Ingram et al., 2007; Jelsma and Knot, 2002; Wever et al., 2008; Zachrisson and Boks, 2012). An often-mentioned example is the speed bump, which suggests car drivers to slow down and thus discourages speeding. Jelsma (2003) discusses four notions related to the concept 'script', when transferring it to design. Scripts have a 1) "prescriptive force", i.e. they steer user's behavior in a certain 2) "direction", which for example increases comfort for users. Scripts can be applied on different 3) "scales", i.e. depending on whether designers take a macro or micro perspective, and entail the 4) "distribution of tasks, responsibilities, and power". The challenge for designers is to "inscribe" the desired user behavior as a message into the structure of products or services (Latour, 1992). Jelsma (2003) mentions that scripts are similar to the concept of 'cues' and 'affordances', as used in psychology. According to Zachrisson and Boks (2012), scripts are situated in the middle section of their continuum between the extremes of either the user or the product being in complete control. However, as Ingram et al. (2007) argue, scripts cannot generate predictions on user behavior, since users might appropriate or re-configure products and services.

Scripting, by treating humans as social agents, which are, for example open to resistance in their response to 'de-scribing' scripts (Ingram et al., 2007), has much in common with the role of meaning in cognition: Both, scripts and meanings are formed by intentions, conveyed through products and services as communicative medium, and rely, as also Jelsma (2003) mentions, on interpretation of the signs in order to be "read and understood". Thus, meaning in design for behavioral change can benefit from the analysis of scripts.

2.3.3 For achieving eco-sufficiency

As mentioned in Chapter 1, sufficiency is about "enoughness", for example of material goods, both qualitatively and quantitatively, on an optimal and acceptable level (Darby, 2007; Princen, 2005). According to Reichel et al. (2009), eco-sufficiency as business strategy implies putting user behavior at the center of design. Boulanger's (2010) formulation of sufficiency as well-being per service[10] highlights the user perspective on sufficiency, i.e. to maintain a level of personal well-being partly disconnected from the consumption of services. This is where the call of Walker (2010) to extend the triple bottom line with personal meaning can come into play.

In design for sustainable behavior, sufficiency has been rarely discussed: only two sources were found. The first is Marchand and Walker (2008), who studied how product designers can support people who are active or interested in simplifying their lifestyles. They conclude that designers should aim for developing objects which allow people "to be engaged in the activity of 'doing'" and perceive personal factors or benefits. The second is the publication of Pettersen (2016) discussing structural constraints on design, such as policies and value definitions, for reaching "absolute reductions in resource use", i.e. sufficiency. She advocates a design approach starting from social practices by users, since it focuses on "shared ideas about normality". In doing

[10] He conceives services in the context of energy and not of market entities: for example, services such as lighting and mechanical power, which are brought about by energy.

so, designers are challenged to keep resource intensity low, "while allowing for diversity in practice performance".

As this brief discussion highlights, the topic 'eco-sufficient user behavior through design' is vastly underexplored. For example, no concept exists about which user behaviors or practices involving products and services can be considered as eco-sufficient. It can also be concluded that the personal perspective on sufficiency needs to be taken into account in theoretical and empirical investigations.

2.4 Summary and refined research questions

Two analytical avenues into meaning are propagated in this thesis: first, analyzing the structure of meaning to describe design-as-communication informed by semiotics and second, analyzing the role of meaning in cognition to link meaning to behavior.

The literature study on the topics meaning in design and meaning in design for sustainable behavior highlights that there are many underexplored areas and no support for designers to design for behavioral change. From a research methodological perspective, meaning seems to not have been empirically investigated using Peirce's triadic model of signs before. Thus, an empirical investigation can shed new light on both sides of the communication process by analyzing the conveyance of designers' intended meanings to users and non-users. Further, the role of meaning in cognition has the potential to link the conveyed meaning and behavior, in this case eco-sufficient behavior.

Literature shows that Peirce's model of signs can be used to describe not only representation and signification, but also inferential interpretation. In addition, the discussion of the semiotic concept of 'codes' highlights inferences as a suitable way to describe human communication. This is supported in design research by Crilly (2011), who concludes that "researching the role of inference in product experience would add to our present knowledge about user response and user behaviour". Thus, inference of meaning is taken as vantage point for studying meaning in this thesis. As discussed in Section 2.1.1, meaning can be equated with conclusions, which are warranted by signs as premises. In order to maintain a symmetrical approach to describing conveyed meanings in products and services, both users and non-user are studied.

The literature study yielded several determinants of meaning. Additionally, I questioned the assumption in design research whether products and services always take the role of signs. Finally, the concept of meaning can be used for describing user behavior, the acceptance or rejection of products and services by users or non-users, and the social construction of technology.

Table 3 summarizes the approach taken in this thesis in the same manner as the design approaches and topics listed in Table 2, allowing a direct comparison.

Table 3: Approach in this thesis

Name of approach or topic (reference)	***Dimensions***				
	Role of meaning	***Area of application***	***…to the purpose of***	***Underlying theories***	***Type of investigation***
Design for Meaning (in this thesis)	Central (inference)	Product as communicative media	Influencing user behavior (eco-sufficient)	Semiotics (Peirce triadic model)	Both (qualitatively, designers, users, non-users)

The theoretical considerations in this chapter introduced several concepts that enable me to refine the research questions in Table 4:

Table 4: Comparison of initial and refined research questions

Initial RQs	*Refined RQs*	*Additional considered concepts*
1. How is meaning made by users, and how is it related to user behavior?	RQ 1: (a) What is the role of meaning in inferential cognitive processing of product and service experiences by users and non-users, and (b) how is the role of meaning related to user behavior?	• The role of meaning in cognition • Inferential interpretation • Users AND non-users
2. What meanings are conveyed to users and non-users through products and services?	RQ 2: What determinants of meaning (a) do describe meaning and its successful conveyance through products and services as a communicative medium, and (b) influence the acceptance of products and services?	• The structure of meaning • Determinants of meaning • Communicative medium • Acceptance as « struggle over meaning »
3. How do meanings made by users and by non-users differ to explain their behaviors?	RQ 3: In what determinants do reconstructed meanings by users and non-users differ to explain eco-sufficient behavior?	• Determinants of meaning • Inferential interpretation • Users AND non-users
4. How can meaning be addressed by designer, and how can they best be supported?	RQ 4: What support can be suggested to designers for addressing the structure of meaning and the role of meaning in cognitive processing in order to achieve the goals of successfully conveying meaning, influencing the acceptance of products and services, and fostering eco-sufficient user behavior?	• The role of meaning in cognition • The structure of meaning

Chapter 3 The relation of meaning and behavior

In order to support designers in creating meaning to foster eco-sufficient user behavior, an understanding is needed of how meaning is reconstructed by users and non-users, that is, the role of meaning in cognition (Section 3.1). In Section 3.2, concepts for relating meaning and behavior are explored. This comprises the first research question. The literature study revealed that meaning making has already been described in much detail, but that in describing behavior, the concept of meaning is only used in an ancillary way. In Section 3.3 I introduce a new model, the Meaning-Behavior Model, which covers both meaning making and its relation to behavior. An initial model has already been published elsewhere (Waltersdorfer et al., 2015b).

Examples for illustrating the discussion are, for better readability, marked in italic and assigned to an own paragraph with increased indent.

3.1 Meaning reconstruction by users and non-users

Meaning making, which I call meaning reconstruction when performed by users and non-users of products and services (see Figure 3), is driven by the need of humans for meaning (Heine et al., 2006). In psychology, the process of meaning making is relevant to describe coping with stressful events in life, and has been extensively discussed, for example by Park (2010). Since she uses the same broad definition of meaning by Baumeister as this thesis, I assume that her ideas on the process can be transferred to other experiences, such as those made through interactions with products and services. Thus, Park is used as the main source in this section to describe the process of meaning reconstruction, which follows the analytical avenue of the role of meaning in cognition.

Meaning making in general aims at searching for comprehensibility, which is described as making an experience “fit with a system of accepted rules or theories”, and subsequently searching for significance by “determining the value or worth” of an experience (Park, 2010). According to Proulx and Inzlicht (2012), through meaning making, one strives for answering “what is going on” and “why it should be so”, and therefore meaning can provide understanding and purpose of an experience.

Reconstructing or making meaning can be considered as a two-stage process: 1. appraising meaning, and 2. comparing appraised with global meaning. Appraising meaning is performed by attributing why an experience occurred and determining its implications through emotional and cognitive processing. Thus, appraised meaning, loosely based on cognitive appraisal, refers to situational intuitive and immediate evaluation of an experience in a particular environmental encounter (Park, 2010). Appraised meaning may already be influenced by global meaning, such as one’s beliefs, but without making comparisons to it. In the second stage, it is determined if and how the experience fits the personal orienting systems, i.e. global meaning (Park, 2010). Global meaning consists of: global beliefs, i.e. core schemas for interpretation, also about the self; and global goals, i.e. “ideals, states or objects” towards which people work (Park, 2008). Global meaning is more stable than appraised meaning.

Ultimately, meaning, defined as mental representation of possible relationships, can connect the self, people, things, experiences, expectations (Proulx and Inzlicht, 2012) (i.e. the future), the past, the present (Park, 2010), places (Manzo, 2003) and, things beyond them all (Vis and Boynton, 2008).

Puntoni et al. (2010) found the two stages of meaning making also other disciplines: in semiotics, these stages are called denotation and connotation; and in consumer research, comprehension and interpretation. Interpretation is defined as "the process of inferring beyond the literal meaning of a message" (Chandler and Munday, 2011). By referring to semiotics, they state that meaning making can be understood as decoding [11] a sign's meaning. Thus, in semiotic terms, meaning making starts from the sign. Puntoni et al. highlighted that interpretation is based on inference.

The comparison of appraised and global meaning may result in a perceived discrepancy – also called self-discrepancy (Heine et al., 2006), violation of meaning (Proulx and Inzlicht, 2012), or cognitive dissonance (Jackson, 2005). Such discrepancy may be caused by conflicts between attitudes, beliefs, values or goals of the self or others (Jackson, 2005). The potentially resulting personal distress can drive more deliberate meaning making efforts (Park, 2010), also called meaning maintenance (Proulx and Inzlicht, 2012), in order to solve these conflicts and to stay self-consistent (Sirgy, 1982).

Proulx and Inzlicht (2012) describe five ways, called the Five A's, of "meaning maintenance": assimilation, accommodation, affirmation, abstraction and assembly. Assimilation involves the adaptation of the appraised meaning to the global meaning; accommodation involves the adaptation of the global to the appraised meaning. The other options are: to remain at the previous understanding and avoid the source of conflict (affirmation), to find something familiar to the discrepancy in the external environment in order to obtain understanding (abstraction), or to create a completely new understanding independent of the global meaning (assembly).

DeGrandpre (2000) sees meaning making as a dialectical process, in which meaning is refined through reviewing a "behavioral episode", and therefore can be considered as a closed loop process. Wright et al. (2003) divide meaning making of past experiences into: reflecting (an inner recounting); appropriating (relating experiences to the self); and recounting (involving others in the review of past experiences). Reflecting and recounting can be seen as reviewing the appraised meaning, and accordingly appropriating as reviewing the global meaning of a person. When meaning making involves reviewing the past it can be described as a learning process (DeGrandpre, 2000).

It can be concluded that meaning reconstruction is conceived as a two-stage process with two closed feedback-loops, i.e. meaning maintenance and reviewing, and therefore the process can be entered through three different points: a need for meaning of direct experiences; a review of past experiences, for example made through behavior; a personal cognitive distress. This conclusion will be included in the model in Section 3.3. As it was already stated before (Section 2.2.3), meaning reconstruction can happen in the contexts of 'observation', 'interfacing', and 'anticipation', in which persons are be engaged with a product or service.

3.2 Concepts for relating meaning and behavior

In this section, several concepts are analyzed, which describe the relation between meaning and behavior. Holzkamp (1985) states that meaning only indicates "possibilities for action", and is not a determinant of action, since one can always abandon one's efforts of making meaning. In many behavioral models, as Darnton's (2008) extensive overview shows, meaning is not included, since it is not a direct determinant of

[11] The term decoding is avoided in this thesis, since it can suggests that interpretation only requires following a specific scheme.

behavior. Therefore, the question is how meaning and human behavior are related, if not through cause and effect, and which other schools of thought and concepts describe this relation.

3.2.1 Meaning and motivation

For Quigley and Tymon (2006), who investigated career self-management, meaningfulness – next to choice, competence and progress – is one of four components of intrinsic motivation: "the feeling of meaningfulness" is aroused when people pursue a "path that they believe is worth their time and energy" towards an objective that matters to them. White (1959) draws on the ideas by Piaget about child development when discussing an individual's "own built-in bit of motivation", which can guide exploratory or playful behavior "for the sole reward of engaging in it". In view of the self-determination theory by Ryan and Deci (2000), meaning also promotes the internalization of extrinsic motivation: by grasping its meaning, people "become autonomous" from external motivations. Thus, these schools of thought support the claim by DeGrandpre (2000) that meaning has motivational qualities, i.e. intrinsic motivation and internalizing extrinsic motivation, which can "guide individual actions".

> *For example, the motivational quality of meaning can be observed with bicycle lovers, diving into every detail of their bike, and taking great care of it (sole reward of engagement).*

3.2.2 Meaning and adaptive attitude

Focusing on organizational change, van den Heuvel et al. (2009) describe the role of meaning making by employees, as "the ability to integrate challenging or ambiguous situations into a framework of personal meaning using conscious, value-based reflection". In turn, they consider meaning making as a personal resource, allowing employees "to remain resilient when confronted with organisational changes". In these circumstances, meaning making forms adaptive attitudes, "such as willingness, openness and readiness to change" (van den Heuvel et al., 2013). This can lead to "a positive behavioral intention towards the implementation of modifications in an organisation's structure, work, or administrative processes (…)" (van den Heuvel et al., 2009).

Since the reflection upon challenging and ambiguous situations can also occur outside the work environment, it is assumed that these findings can be transferred to interactions with products and services.

> *For example, users with affinity to new technologies are open to them and adopt them quickly, as they are easily integrated into their frameworks of personal meaning.*

It is evident that the meaning making process can start from 'personal distress'. At first sight, it seems that the formation of adaptive attitudes is similar to internalizing extrinsic motivation. However, whereas extrinsic motivation focusses on external rewards, whose meaning is grasped during internalization, the formation of adaptive attitudes is triggered by contextual factors such as challenging situations and changing environments.

3.2.3 Meaning and the self-concept

Sirgy (1982) defines the self-concept as the "totality of the individual's thoughts and feelings having reference to himself as an object", and distinguishes the actual (present) and ideal (future) self. Drawing upon several scholars, Sirgy concludes that the self-concept directs behavior "toward the protection and enhancement of [the] self-concept", which can be observed in user behavior based on the symbolic meaning of products and services.

Wright et al. (1992) discuss product symbolism from the perspective of the user's self-concept: accordingly, a user defines him- or herself based on product meanings, resulting in an "extended self". Based in the ideas of self-congruity theory, recognizing product symbolism is the ability to draw personal meaning out of a product (Wright et al., 1992).

> *For example, people who want to become more self-reliant (future self) may take the risk of potentially destroying their tablet when they set out to repair its broken screen with a previously bought repair kit (product) instead of having it repaired by a professional. In this way, they enhance their self-concept and the product takes the role of a symbol referring to their self-reliance.*

In case a discrepancy between appraised and global meaning, as described in Section 3.1, is only anticipated (Higgins, 1987), one may already act to prevent "an aversive sense of meaninglessness" (Proulx and Inzlicht, 2012). As described in literature, a potential discrepancy can be anticipated between the appraised meaning of behavior and the self-concept (Sirgy, 1982), as part of the global meaning, or between the actual self, reflected in appraised meanings, and the ideal self (Jackson, 2005), again part of the global meaning.

> *For example, some people may avoid services, such as long-distance flights, when anticipating that these services would give rise to appraised meanings about their actual selves, such as climate offenders, which would be in conflict with their ideal selves, such as environmentalists.*

3.2.4 Meaning and the social identity

Jackson (2005) draws on symbolic interactionism, when describing that the self-concept also has a social dimension, since the self is negotiated by social conversation. This conversation results in shared values, attitudes, and beliefs of groups, which in turn are part of individuals' global meaning. Consequently, the self and the social identity cannot always be clearly separated.

Based on symbolic interactionism, Lee (1990) discusses the relation between the "socially oriented self" and product symbolism: through products, meaning is communicated to others in social situations, such as conspicuous consumption. The social conversation is what connects people and products, since products can be part of the conversation (Jackson, 2005). In this way, products become familiar and meaningful. "People respond to material artefacts on the basis of the symbolic meanings that these artefacts carry" (Jackson, 2005), and thus become stimuli for action (Lee, 1990). People not only set their actions through meaning making, they also review them in the lights of the products, of the people engaged in the social conversation, and of the socially formed identity (Lee, 1990). One can at least distinguish two social groups in social conversation: the in-group, to which the person belongs or wishes to belong, and the out-group (Jackson, 2005).

> *For example, driving a large sport-utility vehicle (SUV) may symbolize success for the in-group, but may be less accepted by the out-group, because of its resource intensity.*

3.2.5 Meaning and reviewing

DeGrandpre (2000) argues that meaning making by people on the consequences of their actions can indirectly "alter the probability" of their future behavioral actions. This dialectical character of meaning making is supported by Alea and Bluck (2013), who discuss two components of meaning making, in which people review their past: they argue that one component is about actively "searching for meaning" - for example in life or in products - based on past experiences; whereas the other component is about directing present and future behavior by using the adaptive and "directive function of autobiographical memory". Through the second component, contrary to the first, past experiences become meaningful. Since reviewing

involves adaptations, it seems, at first sight, similar to the formation of adaptive attitudes. However, as pointed out by Kahneman and Riis (2005), memory involves two selves: the experiencing and the remembering self. The first self is built during immediate introspection, whereas the second involves retrospection and is dominant in reviewing past experiences. The difference between making meaning of recent and past experiences is that the latter may be biased due to the dominance of the remembering self (Kahneman and Riis, 2005).

> *For example, the dominant remembering self, constituting one's global meaning, may bias the review of appraised meanings of past experiences: when remembering the past experience of riding a roller coaster (behavior of using the service), it may be appraised as a joyful experience, through which one's limits were explored (global meaning). Despite the actual experienced fear during the ride, one might be willing to ride again.*

3.3 Meaning-Behavior Model

In this section, the process of meaning making, or meaning reconstruction (Section 3.1), and the concepts behind the relation between meaning and behavior (Section 3.2) are summarized and integrated into one model, called the Meaning-Behavior Model, which is shown in Figure 4.

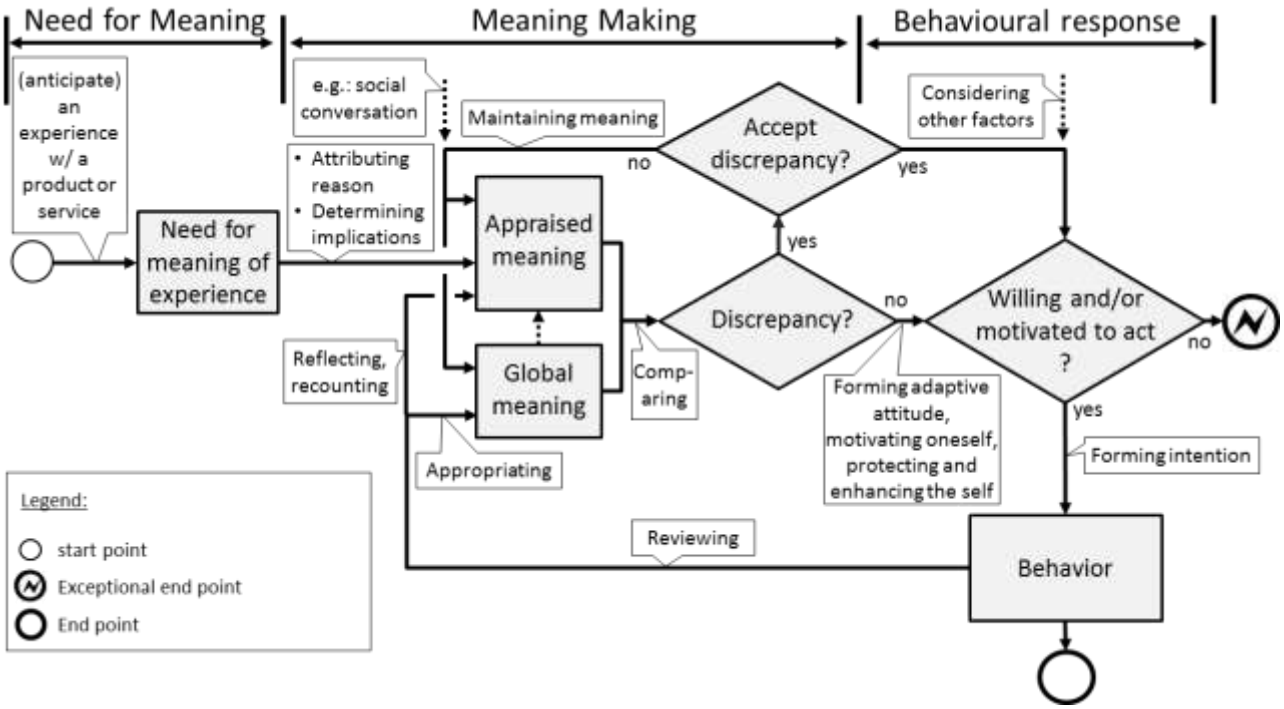

Figure 4: Meaning-Behavior Model

Users and non-users experience products and services through several modes of interaction, as conceptualized by Khalaj and Pedgley (2014). These modes are: preconceiving the product or service; experiencing a representation; visually or multi-sensorial appraisal; and use. Driven by the **need for meaning** (**start point**), (potential) users go through the meaning making process in order to get an understanding of the experience. In a first step, they attribute a reason to that experience and determine its implications, which results in an initially **appraised meaning**. In a second step, this appraised meaning is **compared to the global meaning** in order to determine if and how the experience fits the global meaning, which represents individuals' general orienting systems and self-views. By this comparison, the significance of an experience is

evaluated. Users also consider other influencing factors than the product or service experience in meaning making, such as social conversations. In some case, the comparison can lead to a perceived **discrepancy** between those two meanings, which can be **accepted or not**. In case the discrepancy is not accepted, the meaning needs to be **maintained** by either adapting the appraised or the global meaning. In case the discrepancy is accepted, again by considering other factors, the user may still be able to decide not to act, unless for example if someone is forced to act against his/her global meaning. Meaning making can also involve **reviewing** past experiences after a **behavioral episode**, by appropriating them to the global meaning or reflecting and recounting the appraised meaning.

As a result, the meanings of experiences, both the initially appraised meaning and the meaning made through comparing appraised with global meaning, are mental relationships to the self, to other people, to things, to other experiences, to events, to expectations, to the past, to the present, to places, and to ideas beyond them all. Since meaning only indicates possibilities for action, users and non-users may or may not be **willing or motivated to act**. Either the process ends here, or they form intentions to behave in accordance to the meaning. The process of meaning making may be repeated by reviewing or meaning maintenance.

There are several mechanisms how meaning can be related to user behavior (meaning-behavior mechanisms), once there are no perceived discrepancies:

- Regardless of what relationship may be established, the meaning of an experience can be related to behavior through:
    - the meaning's motivational qualities, i.e. as one of four components of intrinsic motivation for the sole reward of being engaged in the related behavior; and as facilitator for the internalization of extrinsic motivation.
    - the formation of an adaptive attitude towards a changing environment by the experiencing self during immediate introspection.
- When meaning relates an experience with a product or service to the self, i.e. the actual self as part of appraised meaning or ideal self, as part of the individuals' global meaning, users may want to protect and enhance their self-concepts at any time, also if a discrepancy of meanings is only anticipated, and behave accordingly. In such experiences, products and services can act as symbols.
- When meaning making is influenced through social conversations, which either result in shared beliefs, as part of global meaning, or provide the situation for communicating meaning, people may set their actions in response to these meanings.
- When meaning making involves reviewing past experiences resulting from past behavior, meaning can alter the probability of future behavior. The past experiences can either be the subject of new meanings or facilitate finding meaning in something else.

3.4 Summary

A Meaning-Behavior Model has been proposed, including the meaning making process and the mechanisms for relating meaning and behavior (meaning-behavior mechanisms). This model can inform empirical explorations into the design for sustainable behavior. The Meaning-Behavior Model covers the different types of self as part of the global meaning for relating meaning and behavior and describes when meaning making can end. In this chapter, meaning making was linked to the theoretical considerations on semiotics, and the role of the sign was highlighted as starting point.

Now, it is possible to answer the first research question: what is the role of meaning in inferential cognitive processing of product and service experiences by users and non-users, and how is the meaning's role related

to user behavior? Meaning is the result of interpreting experiences by mentally relating them to other ideas. These mental relations are established by attributing reason to an experience and determining its implications. An important concept in meaning making is the comparison between an initially appraised meaning and one's value system. Only when the comparison does not result in a discrepancy, the meaning is successfully made. Since humans have a need for meaning, they seek meaning automatically and deliberately. The start points for meaning making are signs, a term lent from semiotics. Signs are the part of experiences, or its environment, which is relevant enough to be perceived and further processed. The relations in meanings may not be established in one go, but require additional effort in cognitive processing, which is called meaning maintenance. During meaning maintenance, the initially found mental relations are refined. Further, meaning as mental relations is not carved in stone, but can be reworked by reviewing.

There is neither a causal relationship between meaning and behavior, nor a single direction. Rather, meaning and behavior are interrelated and can reinforce each other. The literature study highlights the importance of the self for relating meaning and behavior. Thus, personal meaning, i.e. mentally relating an experience to one of the various selves, may be best suited to explain behavior. Other mechanisms for relating meaning and behavior are intrinsic motivation and adaptive attitude.

The results of this literature study are taken up in Chapter 4 to inform the data analysis of the empirical study, and in Chapter 6 to derive design recommendations.

Chapter 4 Characteristics of the empirical study

In this chapter, the characteristics of an empirical study into the transfer of meaning and its relation to user behavior in practice are described, based on the theoretical and methodological considerations in Chapter 2 and Chapter 3, yielding underexplored areas of meaning in design and mechanisms relating meaning and behavior. First, a short theoretical background is provided explaining the choices of the studied behavior and service examples. This is followed by a description of the study participants and data collection methods. The main part of this chapter comprises the procedure for the analysis of the empirical data based on content analysis of Mayring (2015), including the new operationalization of the determinants of meaning. Finally, the inter-rater reliability of the data analysis is assessed. Concurrently with the analysis of the study transcripts, two tools are developed, the MOSC-entities and the MeaningMap, which are applied in the analysis. The tools and parts of the operationalization have been published elsewhere (Waltersdorfer et al., 2017).

Examples for illustrating the discussion are, for better readability, marked in italic and assigned to an own paragraph with increased indent.

4.1 Background

As concluded in Chapter 2, no empirical study has been found with the same methodology as preferred for this empirical study: a qualitative approach combined with Peirce's triadic model of signs. Therefore, the empirical study is explorative by nature.

The study strives for answering the following research questions (RQ):

RQ 2a: What determinants of meaning do describe the successful conveyance of meaning through products and services as a communicative medium?

RQ 2b: What determinants of meaning do influence the acceptance of products and services?

RQ 2c: What are factors of reconstructed meanings, which have not been intended by designers, but can improve the communicative potential of services?

RQ 3: In what determinants do reconstructed meanings by users and non-users differ to explain eco-sufficient behavior?

Research question RQ 2c was added, since the comparison of intended and reconstructed meanings to determine their congruence lends itself to explore unintended factors of meaning in order to further inform design for meaning. Table 5 summarizes the dependent variable of each research question.

Table 5: Dependent variables for answering the research questions distinguished by types of participants as data sources

Research question	*Types of participants as data sources*		
	Designers' intended meanings	**Users' and non-users' reconstructed meanings**	**Users' and non-users' behavior of adopting or rejecting a market entity**
2a: Successful meaning transfer	Levels of congruence		
2b: Acceptance of service		Valence of meaning statements	
2c: Improving the communicative potential of services	Unintended factors of positive or neutral meaning statements		
3: Relation between meaning and behavior		Differences between users and non-users	

4.1.1 Products, Services, and Product-Service Systems

Following the ideas by Shostack (1977), every 'market entity', product or service, can be described along a continuum depending on how much weight it puts on intangible and tangible elements. However, even though services are intangible-dominant, for example due to providing "'experience' (movies), 'time' (consultants), or 'process' (dry cleaning)" (Shostack, 1977), the objects of interest for design, as argued by Secomandi and Snelders (2011), remain on the tangible aspects of interface and infrastructure of a service. They define service interface as the "sociotechnical resources" of a service, which actualize intangible elements in the formation of a service, materialize an exchange between companies and users, and "require the mobilization of infrastructure resources", which in turn are less directly involved in this exchange (Secomandi and Snelders, 2011).

The concept of product-service systems (PSS) has sparked interest in research, due to environmental and economic hopes connected to it (Tan, 2010). For the purpose of this thesis, PSS are defined through connecting them to one of many similar concepts: 'servitization' (Boehm and Thomas, 2013; Clayton et al., 2011; Hänsch Beuren et al., 2013; Tukker, 2013; Velamuri et al., 2011). Through 'servitization', i.e. transitioning towards services, purely tangible market entities acquire more intangible elements and in turn are considered as **product-service systems in a broad sense**. Therefore, PSS are the outcome of the servitization process. For design, as for this thesis, servitization is examined from a 'market entity' perspective (Morelli, 2002). Organizations (e.g. Clayton et al., 2011) and the economy (e.g. Dewit, 2014) provide other perspectives on servitization.

In addition to the transition of market entities, it is stipulated here, two further aspects of PSS are of interest for design: first, whether the tangible elements of the market entities are designed for the purpose of servitization, and second, whether these elements are part of the interface between the company and the user. Only when both aspects are given, market entities are considered as **PSS in a narrow sense** for the perspective of design. A design activity is considered to be to the purpose of servitization when it synthesizes tangible elements in order to allow the market entity acquiring more intangible elements. In this narrow sense of PSS, it does not matter if the same company develops and provides the service or not, as long as the two conditions – tangible elements being designed to the purpose of servitization and being part of the interface – are met. The distinction between narrow and broad sense of PSS is important for design as it highlights the role that design can play in servitization. Contrarily, in the broad sense of PSS, the role of an organization in servitization can be highlighted.

> *For example, a car can be a purely tangible market entity, when it is bought without any intangible elements such as maintenance plans. From the perspective of the economy, servitization can already*

happen, for example by the advent of insurance companies mitigating the intangible risk of car accidents, which increases the share of intangible elements in the composition of the economy, measured by the gross domestic product. Similarly, from the perspective of an organization, a car manufacturer or dealer can servitize by starting to rent out cars. The car becomes part of the company-user interface, next to the rental contract, however, it was not designed for the purpose of servitization. Car sharing is an example of a PSS in a narrow sense: besides a web interface, the car itself is designed for the purpose, for example by integrating a card reader, as part of an access control system, and is part of the company-user interface. It does not matter which company synthesizes the car, card reader, access control system and web interface: it could be the provider or a subcontractor.

It is further stipulated that products, services, and PSS can be described by the same conceptualization of their life cycles, consisting of the phases: formation; exchange; use; return. The formation of a market entity is considered as the arrangement of sociotechnical resources in order to allow a company to enter into the exchange with a user (Secomandi and Snelders, 2011). The exchange consists of the delivery, provision, or transfer of the market entity by or from the company to the user in return for a counter value. The use phase is considered as the application of the market entity to any end. The application might also be an end in itself. Finally, the last phase is the return of the market entity to any system from which it originated, such as the eco-system, organizational or technical systems, but not necessarily in the same state as during the exchange.

It is noted, that in this terminology of the life cycle, the formation of a market entity is considered as the preparation for the exchange, which can already involve the user, but not as the actual exchange. The market entity is delivered during the exchange phase, which might consist of several process steps. This distinction between formation and exchange is made in order to avoid the term service production, which may involve the formation as well as the delivery (cf. Agya Yalley and Singh Sekhon, 2014). The value of this distinction is evident for services, which require a high involvement of their users. For example, the market entity haircut involves its users already during formation: the users need to become part of an arranged interface, which allows the hairdresser to deliver the haircut during the exchange. As in the discussion of PSS, it is again the interface, which is of importance.

In Table 6, the life cycle phases of products, services and PSS are compared using examples for each category of market entity.

Table 6: Life cycle of products, services, and PSS

Market entity	***Example***	***Phases of the life cycle of a market entity***			
		Formation: arrangement of sociotechnical resources	**Exchange:** delivery, provision, or transfer of the market entity	**Use:** application of the market entity	**Return:** of market entity to any originating system
Product	Car	Manufacturing of the car	of ownership and car	car's application	to technical and/or eco- systems
Service	Car insurance	(Co-)production: setting up insurance policy	of signatures on the policy about insurance coverage	filing an insurance claim	Cancellation of the policy
	Rental car	Investment in car by a company	of car and a limited right to use it	car's application	of car
PSS	Car sharing	Manufacturing of the car, designed to the purpose of servitization	of car and a limited right to use it	car's application	of car

Based on these theoretical considerations, it is now possible to discuss the selection of the behavior and service examples for the empirical study.

4.1.2 Studied behavior and service examples

As mentioned in Section 1.1, the motivation of this thesis is to foster eco-sufficient user behavior by design. From the perspective of consumption, eco-sufficiency is defined as the voluntary "self-limitation of material needs" (Huber, 2000) to reach a level of "enoughness" (Princen, 2005). In order to translate eco-sufficient user behavior to design, different categories of user behavior are collected with regard to the life cycle of market entities. These categories facilitate the selection of the behavior to be studied.

Eco-sufficient user behavior can take place in every phase of the life cycle. During the 'formation' phase, users might take influence through co-creation (Sebastiani et al., 2011), for example in order to limit the resource intensity of a market entity. During exchange, one behavior is to simply avoid buying a specific market entity such as through organized boycotts (Friedman, 1995). Another way is to buy 'right', by reconsidering one's habits and needs (Alexander, 2009) and choosing simpler or multifunctional market entities. Eco-sufficient behaviors addressing the use phase are: keeping, reusing, and repairing market entities to avoid replacing an existing market entity. Finally, users can also 'return' a market entity in order to reach a level of "enoughness" and request from the company to take it back, or make sure that the market entity is recycled in a way to conserve its maximum value.

The examples of eco-sufficient behaviors in the use phase were based on the assumption of ownership of a market entity. However, in addition to reconsidering one's material needs, one could also reconsider how one's needs are met [12]. The reconsideration points to the concept of sharing, the practice of having or using something with another or others (OxfordDictionaries, 2017). From the perspective of the life cycle, eco-sufficient user behavior of sharing potentially stretches across all phases: whereas it is obvious that users exchange, use, and return shared interfaces of market entities, they might also be involved in the arrangement of resources during the formation of market entities.

Due to these factors, i.e. potentially reconsidering how needs are met and stretching across all life cycle phases, the user behavior of sharing is especially interesting to meaning making and design, and therefore chosen for the empirical study. Due to technological advancements, many companies have been established, which can be classified as part of the sharing economy, but which involve different sharing types. Only one category of eco-sufficient user behavior is studied in order to allow the researcher a comparison between these different types of market entities. The term user behavior is favored over consumer behavior in order to emphasize the potential involvement of users in the formation of the market entity, and their various roles throughout the life cycle, which go beyond the mere consumption of market entities.

From the perspective of different behavioral change strategies in design (see Section 2.3), the eco-sufficient user behavior of sharing can be considered as a script of a market entity. "Scripts are the structural features" of market entities, which steer "user action in certain directions while counteracting it in other directions" (Jelsma, 2003). Through exploiting these features, designers can limit the environmental impact of market entities (Ingram et al., 2007; Zachrisson and Boks, 2012).

It is assumed that the partly prescribed behavior of sharing by the market entities is especially interesting to be studied through meaning making by users and non-users, since meaning making aims at searching for comprehensibility and significance (Park, 2010). Despite its stretch across the whole life cycle, the most critical phase for sharing is the 'exchange', on which all subsequent phases rely. Therefore, this empirical study focuses on the adoption and rejection of market entities, which involve the practice of sharing.

[12] Some commenters even go further and question the concept of the market entity, when propagating self-subsistence, i.e. meeting one's needs by oneself.

Rejections are also considered in order to remain true to the principle of symmetry (see Section 2.2.2). Additionally, the acceptance of market entities by non-users, "characterized by a […] positive thinking" about them (Miceli and Castelfranchi, 2001), is studied, since it is considered as a prerequisite for making 'exchange' happen (cf. Bagozzi and Lee, 1999).

The following types of market entities are identified by an online analysis of market participants (Table 7): PSS, Peer-to-peer (P2P) and Multi-service (MS), which are called 'sharing types' throughout the thesis. Market entities falling in these types of sharing are services since their dominant elements are intangible. The services' characteristics are defined in a data-driven way from the online analysis, except of the types of good according to Ostrom (2010). Bikes and washers were chosen as the shared goods due to several reasons: first, to allow the researcher making comparisons between two market entities; second, to compare goods of a similar price range; third, to cover both rather conspicuous (bike) and inconspicuous consumption (washer); and fourth, to cover different practices, being either mobility or chore. The first sharing type is called a product-service system (PSS) since its interface, i.e. the shared good, is designed to the purpose of servitization. The second type is peer-to-peer sharing (P2P). For P2P, the service provider is an intermediary between private people. Through the provider's platform demand and supply of privately owned goods are matched. The third sharing types are multi-services (MS), which combine several services, such as preparing coffee, in a single service space and require a service worker.

In total, six service examples are included in the empirical study, one for each sharing type and shared good. The description of the services, as it was presented to the study participants, can be found in Appendix A.

Table 7: Identified sharing types for bikes (b_) and washers (w_)

Characteristics	*Sharing Types*		
	Product-service system (PSS)	***Peer-to-peer (P2P)***	***Multi-service (MS)***
Types of good (Ostrom, 2010)	b_: Club good w_: Private good	Private good	Private good
Shared goods are owned by	the company	Both: Individuals b_: also other companies	the company
Interfaces (in addition to shared good)	Both: web app, kiosk b_: stations w_: service space	web platform	Café, service space
Support for sharing	Shared goods: designed to the purpose	Intermediary: meeting supply and demand	Additional services: cafe, events w_: Shared goods: designed to the purpose
Involvement of user in formation	b_: No w_: Yes, loading washers	Yes (provision of shared good by the owner, sign-up, arranging a meeting)	b_: No w_: Yes, loading washers
Social interactions	Not needed	Required: between private persons (b_: also professionals)	With service worker: b_: required w_: possible
Dominant intangible elements	access	information	Cafe: experience Rental: access
Reach	city	country	city

4.2 Method

The aim of the empirical study was to explore the successful transfer of meaning in products and services from designers to users and non-users in order to inform design-as-communication. A qualitative approach was taken involving semi-structured interviews for data collection since the empirical study is explorative by

nature and interviews can be adapted flexibly. Peirce's triadic model of signs was used for describing the inferential interpretations behind meanings and deconstructing them. The results of the empirical study are reported and discussed in Chapter 5.

4.2.1 Participants

To answer the research questions, data collection involved designers, users and non-users for each of the six service examples. Ideally a designer, three users and three non-users should be interviewed in order to make comparisons between the service examples.

First, designers of services were recruited and interviewed in order to make sure that subsequently users of the right services could be recruited. Designers were recruited by contacting the founder or front office via email, LinkedIn or the company website. Forty-two companies were contacted, of which 15 were willing to participate and were interviewed. All participating companies were relatively young small or medium sized companies: only one was established before 2004. One out of 15 interviewed company representatives was trained as designer. For services involving the sharing of bikes, four founders, one owner, one consultant (who initiated the venture into sharing), and one store manager were interviewed. For services involving the sharing of washers, six founders, one owner, and one director of sales were interviewed. Since all company representatives were able to answer all interview questions, which covered mostly the intended meanings and some design decisions, their different positions in the companies was not an issue. Some company representatives mentioned their position in the company during the course of the interview, for others it was clear from the website of the service.

A variety of sampling techniques were applied for recruiting users and non-users: convenience sampling through social media websites; classified ads websites, and announcements at the service spaces; snowball sampling by asking if interviewees could recommend further participants (which only worked two times); purposive sampling by directly contacting people, who mentioned having experience with a service on social media websites. After completion of the interview, users and non-users received a € 20 (or national currency equivalent) online voucher as compensation.

In total, 41 (non-)users were interviewed, 19 on all services involving bike sharing and 22 on services involving washer sharing. Of these 41 interviewees, 61% were female, 37% were between 18-25 years old, 34% between 26-35, 14.5% between 36-45 and 14.5% between 46-55 years. Thirteen interviewees lived in the USA, twelve in Germany, seven in the UK, four in Australia, four in France, and one in Portugal at the time of the interview.

4.2.2 Material

Three lists of questions were developed in preparation for interviewing designers, users, and non-users. These lists had a set of similar questions in order to allow the researcher to make comparisons between these groups of people. The questions guided the semi-structured interviews and were inspired by the theoretical considerations about meaning (Section 2.1.1). Additionally, interviewees were probed on interesting topics, such as by asking to elaborate on the topic. The questions are summarized in Table 8.

Table 8: Overview of interview questions

Underlying considerations	*Designer*	*User*	*Non-user*
Knowledge about service		Could you please tell me how you came across the service? And about your experience with the service?	Have you heard about the service or a similar one?
Clarification	What services does your company offer?		
Role of designer	In which capacity have you been involved in the development of the rental service?		
Target group	What are your target groups? How did you define them? Are the main users a different group than originally intended?	For whom do you think is the service meant for?	
Projective quality of service;	Would you say that the service tells something about its users?		What image do you get from people using the service?
interviewing technique: 'deflection' (service as sign) (incl. thoughts by others)		Have you told your friends about the service? If yes: how did they react? If no: how do you think would they react?	Let's imagine that you used the service and then you tell your friends about it: how would they react?
First impressions, associations	What, in your opinion, should users associate with the service? And why?	What were your expectations towards the service before using it the first time?	What was the first thing that came into your mind, when you have read the description of the service?
Prompted to infer intention; Expressive quality of service	What message, in your opinion, should the service convey to users? And why? By what is the message expressed? Do you have the feeling that users get the message?	What do you think is the message that the service tries to convey to its main user group? And why? By what is the message expressed? Do you think of a different message that a greater audience could get?	
Denotation. Meaning making: attributing reason (1)	What is the idea behind the service? And why?	What do you think is the idea behind the service? And why?	
Influencing factors on design	How did you realize the intended idea in the service?		
	Did you obtain the opinion of potential users before launch?		
	What were obstacles or success factors?		
	What are in your opinion the main requirements on this type of service for being successful?	What are in your opinion the main requirements on the service to be successful?	
Social consequences of service. Meaning making: determining implications (2)		Do you think of any positive or negative social implications that come with this service?	
Personal significance. Provoking self-referential statements		Would you say that the service is somehow important to you? If yes: why?	
Perceived potential for behavioral change		When we compare the three services: which one has in your opinion the highest potential to be a substitute for owning the [shared good]?	
Importance of shared good.		What is the role of the [shared good] in each service?	

Underlying considerations	*Designer*	*User*	*Non-user*
Demographic data		How old are you? What is your city of residence?	

The question about the intention of designers allows a communication theoretical perspective. The process of meaning making, as described in the Meaning-Behavior model (see Chapter 3) was considered in two interview questions, which prompted the interviewees to attribute reason (1) to the discussed service and determine its implications (2). The question about the social consequences of service was added after the first interviews in order to include the distinction between personal and collective concerns (Tromp, 2013), since it turned out that social consequences addressing collective concerns rarely came up in the discussions of the service.

In order to support the discussion of the six service examples and to provide each interviewee the same minimum level of knowledge, each service example was described on a single A4-page including 3 pictures of the interior and exterior, the web app or website of the service, which were published by the companies online. The following details were included: business model, geographic and timed availability, price structure, payment options, prerequisites for use, use process, additional features or services, and specificities of the shared good. The price of each service was not provided to avoid a discussion about pricing, which is mainly part of marketing. These descriptions were distributed to the interviewees in advance, who were asked to read them as a preparation for the interview. Therefore, following the classification of Khalaj and Pedgley (2014), the product interactions by non-users were based on "visual appraisal of product representation" (in some cases they had seen the product, for example on holiday), and the product interactions by users were based on "use of product". The description of the services can be found in Appendix A.

4.2.3 Data collection

Since the recruitment of users and non-users was done in a variety of ways, the following process was developed to streamline the sign-up process. Interested persons could sign-up by filling in a form. Depending on the method of recruitment they could reach the form directly or after contacting the researcher, who then provided the link. The form provided the first data: name of service the interviewee knew; knowledge about the service (just knowing, having used the service or different parts of it, other); email address for further communication such as confirming the date of the interview, and delivering the online voucher; pseudonym; contact details for interviews (email address; phone number; user name of Voice-over-IP (VoIP) service; informed consent). After filling in the form, interested persons were automatically forwarded to another web-service where they could choose a date and time-slot for the interview. Appointments with designers were scheduled by email.

Interviews were conducted one-on-one in either English or German via VoIP or phone and recorded. Interviewees could choose between two VoIP services and a phone call for the interview during the sign-up process and needed to provide the necessary contact details. The interviews took 30 min for the companies and 30-60 min for (non-)users, depending on the amount of information they provided. All (non-)users were interviewed on all three sharing types for either bike or washing machines. In this way, each user or non-user contributed to the discussion of three services; of some they were users, of others they were non-users. The self-reported behavior during the sign-up process was checked by knowledge questions about the service.

The recorded interviews were transcribed in the same language as the interview, but coded and further analyzed in English. The transcriptions amount to more than 200,000 words.

The following table (Table 9) provides an overview of contributions per shared good and sharing type resulting from the data collection.

Table 9: Result of data collection per shared good and sharing type

Shared good _ sharing type	*Number of interviewed designers*		*Number of contributions by*			
	included in analysis	***excluded from analysis***	***users of same as included service***	***users of comparable service***	***non-users of same as included***	***non-users of comparable service***
b_P2P	1	1	6		12	1
b_PSS	1	1	5	6	3	6
b_MS	1	2	1*	2	13	
w_P2P	1	1	1*		20	
w_PSS	2	1	1	2	17	1
w_MS	1	2	3	2	16	1

Legend: Shared good: b: bike; w: washer
Sharing type: P2P: peer-to-peer; PSS: product service system; MS: multi-service
*: using another part of the service than the rental service

As the table mentions, some interviews of designers were excluded from further analysis after being transcribed since not enough users were interviewed for these services and therefore the captured intended meanings could not be analyzed in terms of their successful transfer to users. Regarding the service example w_PSS, representatives of two companies were interviewed: one designer of the cashless payment system and one laundromat owner applying this cashless payment system. Since they expressed similar intended meanings but no opposed ones, their intended meaning statements were combined in the analysis.

Some users and non-users were interviewed about comparable services. Those comparable services, about which no designer was interviewed, were part of the study, since the study was advertised by asking whether people know or use specific service categories such as ‘bike cafés’, as the colloquial term for the service b_MS, instead of asking for a specific service example, in order to ensure anonymity of the participating companies. Only the services of b_PSS were similar enough to include them in the analysis about the successfully meaning transfer. However, the other comparable services still informed one analysis, which is marked in Appendix C (‘all services’ in the third column). Two users only had experience with other parts of the included service than its rental service. One user went to the service example b_MS only for a drink, at least interacted with parts of the service space, and therefore got more insight into the service than a non-user, who has never been there. The other user provided his washer on the platform of the service example w_P2P.

Table 9 shows that the services b_P2P, b_PSS, and w_MS have most contributions by both users and non-users. The sums of the contributions by users and non-users does not always equal the number of participants (19 for bike related services and 22 for washer-rental services) for several reasons: one interviewee was only interviewed on two services due to time constraints; one had to leave after discussing one example; one non-user mixed up two services and therefore the contribution cannot be used; and some interviewees contributed to more than one service of the same type.

4.3 Data analysis

Examples for illustrating the analysis are marked in italic and assigned to an own paragraph with increased indent.

4.3.1 Overview

The transcribed interviews were analyzed using content analysis (Mayring, 2015): the analysis aimed at the subject matter of the text (direction of analysis), i.e. the meanings in products and services, on the level of clauses stated by individuals. Therefore, meanings in products and services were derived from whole statements rather than single words. However, the interview transcripts were coded to the level of single words as the smallest coding unit. The context unit was the whole interview, which could be used for explication. The starting point of the data analysis was the identification of inferences made by interviewees, which contained meanings that they had found in the services. For operationalizing meaning, i.e. defining it in terms of the operations for its determination (Neuman, 2014), Peirce's model of signs was compared to logic. Based on this comparison, a sequence for deconstructing inferences and the contained meanings was developed. Next to meaning, the second unit of analysis was user behavior, i.e. either adopting or rejecting a service, which was determined by self-reports during the sign-up process and checked by questions about the services.

The content analysis consisted of following steps following Mayring (2015):

1. The interview transcripts were reduced by identifying inferences and the contained meanings using the software NVivo 11.
2. The identified inferences and the contained meanings were deconstructed and structured concerning content and form and linked to aspects of services by deductive nominal category assignment (theory-driven) and inductive nominal category development (data-driven), i.e. coding. These categories are called **‚determinants of meaning‘** throughout the thesis. MS excel was used for this step.
   The analysis was supported by the MOSC-entities and the MeaningMap, two tools, which were developed concurrently with the data analysis, and which can be applied in both, research and design methods.
3. For some assigned categories a narrow contextual analysis was needed.
4. The resulting categorical nominal data was compared using contingency tables and statistical tests of independence. The significance level was set to 5%. Depending on the available data, the following tests were applied: Pearson's chi-squared test, two-tailed Fisher’s exact test (for 2x2 contingency tables with expected values below 5), and Freeman-Halton test (for 2x3 tables with expected values below 5) [13]. Besides, Cramer’s V was calculated as a measure of association.
5. Based on the content analysis of step 2 and 3, further categories were developed inductively for each research question from the discussion of particularly interesting meaning statements, which shared common themes. These categories are interpretations of why the meaning statements were part of the themes and are called **‚influencing factors‘** throughout the thesis. The common themes, which can be regarded as a reduction of applicable meaning statements, were:
   - Mostly successfully or unsuccessfully conveyed intended meanings,
   - Controversial intended meanings,
   - Rarely addressed intended meanings,
   - Incongruently reconstructed meanings with negative, positive or neutral valence,
   - Meaning-behavior mechanisms specifying differences between users’ and non-users’ or between individual users’ meaning statements.

[13] The values of Pearson’s chi-squared test and for Cramer’s V were calculated in MS Excel; the values of Fisher’s exact test and of Freeman-Halton test were calculated by a web-based tool provided by Uitenbroek (1997).

Table 10 provides an overview of all variables and their values used in the following data analysis steps: category assignment, statistical testing of independence, and development of influencing factors. Variables can be distinguished by whether they and their coding rules were defined and determined in a theory-, data-driven, or mixed manner. Four cases were distinguished, which were also considered in Table 10 through color-coding:

1) purely data-driven, i.e. variables and rules were defined and determined inductively based on the interview data;
2) purely theory-driven, i.e. derived from theory;
3) a combination of both, i.e. theory-driven categories were extended by inductively developed categories; and
4) theory-driven definitions of categories combined with data-driven coding rules.

Table 10: Variables and their values applied during data analysis

Variables of meaning statements (= determinants of meaning)		*Values (= Categories)*						
Statement made by		designer	user	non-user				
Statement about service examples	**shared good**	bike (b_)	washer (w_)					
	sharing type	product-service system (PSS)	Peer-to-peer (P2P)	Multi-service (MS)				
Types of meaning		intended meaning by designer (M1 - M15)	reconstructed meaning by user or non-user					
MOSC-entities for deconstructing inferences		meaning = conclusion	object = reference point of an inference	sign = premise	concept = idea behind the move from premise to conclusion	(situation = informative, not necessary conditions)		
Levels of congruence		full	high	medium	low	incongruent	conflictingly incongruent	
Successful meaning transfer	**conveyance (designer's perspective)**	yes	no					
	reconstruction (non/user's perspective)							
Addressed intended meaning by user or non-user		yes	no					
Addressed MOSC-entity	**sign**	congruent	conflictingly incongruent					
	concept							
	a variation of them							
Basis of relation between sign and concepts	**of intended meaning**	causality	convention	similarity				
	of reconstructed meaning							
Reference of MOSC-entity	**of intended meaning**	service as a whole	processes	people	technical system	context of the service	business model	

Determinants of meaning

Variables of meaning statements (= determinants of meaning)		*Values (= Categories)*					
to layers of MeaningMap (on level 1)	**of reconstructed meaning**						
Valence	**of intended meaning**	positive	neutral	ambivalent	negative		
	of reconstructed meaning						
Interviewee being prompted to infer intention		yes	no				
self-referential meaning statement	**by user or non-user**	yes	no				
Meaning statements including thoughts by…		interviewee	others				
Ways of inquiry	**for reconstructing meaning**	interfacing (by users)	observing (non-user)	anticipating (non-user)			
Meaning-behavior mechanisms	**specifying self-referential reconstructed meanings**	enhancing self-concept	protecting self-concept	relating to others	relating to the past	adaptive attitude	Motivational quality

Legend: Definition of variable's values and rules for coding:
- Data-driven
- Theory-driven
- Theory- and data-driven
- Theory-driven definition; data-driven rules for coding
- N.A., e.g. since derived from another variable

In the following sections, details about the analytical steps, the coding, and the support tools are provided, and illustrated by examples.

4.3.2 Identifying inferences

In order to identify inferences (premises and conclusions) in the interview transcripts, indicating words were sought such as, 'because', 'since', 'as', 'follows from', for premises, and words such as 'consequently', 'therefore', 'hence', 'so', for conclusions. Since these indicating words had not always been made explicit in the interviews, they were temporarily added to sentences in order to check if an inference became clearer without changing the meaning of the statement. Throughout the thesis statements by interviewees, in which an inference was identified, are called meaning statements.

> *For example, a non-user (Anonymikus) of the service example w_PSS answered, after being asked, what she thinks that the idea is behind using the laundromat through a smartphone: "Well, that again everything will be more electronic. I am not a big fan of such a laundromat. […] it requires playing around on the smartphone, instead of just using the washing machine by hand."*
>
> *By temporarily adding 'since', the premise was identified: 'it requires playing around on the smartphone'. The statement was interpreted as making two conclusions. The first one was 'that everything will be more electronic', which in turn led to the second conclusion that she is not a big fan of such a laundromat.*

4.3.3 Operationalizing meaning to deconstruct inferences

For operationalizing meaning, Peirce's model of signs was compared to logic. As stated in Section 2.1, signs exist through inferential interpretation. In logic, making inferences is about moving from premises to conclusions. The starting point for an inference in logic is the premise (Walton, 1990); in semiotics by Peirce, it is the sign. Therefore, sign and premise can be equated (cf. Nesher, 1984). The endpoint of an inference is the conclusion in logic, and the meaning in semiotics. Conclusion and meaning can also be equated. The move in logic from premise to conclusion by means of a rule, a frame or an idea, is represented by the interpretant in semiotics (cf. Nesher, 1984; Walton, 1990), i.e. in this thesis called 'concept' (see Section 2.1.1). Since the sign stands for the semiotic object to which the concept refers (CP 1.541), the object can be equated with the reference point of an inference, i.e. the grammatical subject of a conclusion (Jorgensen, 1959). Thus, the semiotic object specifies about what a conclusion is made of and in turn specifies the move towards the conclusion: inference is about moving from premises to its reference point in order to make a conclusion about this reference point. It is highlighted that this comparison to logic does not entail that meanings are necessarily based on pure logic, but that logic can support the analysis of meaning.

In summary (Table 11), the following terms from logic and semiotics were equated based on the discussion of inference above:

Table 11: Equated key terms from semiotics and logic in rows

Semiotics	*Logic*
meaning	conclusion
object	reference point of an inference / subject of a conclusion
sign	premise
concept / interpretant	the move from premise to conclusion

These (semiotic) terms are the entities of **deconstructed inferences** and the contained meanings. Consequently, these entities were used as categories in deductive, i.e. theory-driven, coding. The entities were assigned to parts of the meaning statements of the interview transcripts, which contained inferences, in the following sequence: meaning (M) as the already identified conclusion, object (O), sign (S), concept (C). This sequence is called the **'MOSC-scheme'**, and the involved entities are called '**MOSC-entities'**. Guiding questions were used to identify the entities:

1. object: 'what is the conclusion made about?'
2. sign: 'what is a premise or an indication for the conclusion?'
3. concept: 'on what idea is the inference based on?'

The sequence was defined based on the ease of the identification of the entities. In some cases, the 'sign' was obvious, since it was identified through an indicating word, and therefore identified before the object. In any case, most important was to first identify object and sign and last the concept, since it was the concept which connected all entities. Once the entities had been assigned to the parts of the meaning statements, the plausibility of their relations based on Peirce's sign model was checked through posing the following questions:

- ‚Does the inference start from the sign, does the sign give rise to the concept and does the sign relate to the object?'
- ‚Is the object more interesting for the interviewee than the sign?' (cf. Anderson, 1933)
- ‚Does the concept allow the interviewee to draw a conclusion about the object?'

Continuing the discussion of the example from above, the conclusion, which can be equated with the meaning, was 'that everything will be more electronic'. Asking oneself 'about what the conclusion is

made?' draws the attention to 'everything'. It would have been necessary to probe the interviewee, if she meant 'everything about the laundromat' or 'everything, as a general development in culture of her country'. It is assumed the latter.

In this case, the premise, which can be equated with the sign, was already identified in the previous step: ''it requires playing around on the smartphone'. The concept was identified by asking for the idea, on which the inference was based: 'becoming more electronic'.

The following statements can be made from the plausibility check: the sign was the starting point of the inference, since it is assumed 'the requirement to play around on the smartphone' was the first thing that the interviewee thought about, which led her to the generalization that 'everything will be more electronic'. It is further assumed that 'everything', as a general tendency in the culture of the interviewee's country, was more interesting for the interviewee than 'the requirement' and therefore it is plausible that it is the semiotic object. Finally, it is also plausible that the sign gave rise to the concept of 'becoming more electronic', since also the smartphone, as an electronic devise, made the laundromat 'more electronic', which in turn supported her conclusion about 'everything'.

For the deconstruction of some inferences behind meaning statements, an additional entity was considered. This entity was called '**situation**' and covered conditions or assumptions, which specified the meaning statements. These conditions or assumptions were identified in a narrow context analysis by looking for keywords such as '…when travelling or picking up a bike'; '…if you have no cash with you'; '…as a tourist'; '…compared to a normal laundromat'; '…while waiting'; '…in my hometown'. Since the entity 'situation' had only an informative but not a constitutive character for describing meaning, and did not cover all meaning statements, it was only considered in exemplary meaning statements for illustrating the statistical analyses. However, the entity can be relevant to design since these conditions and assumptions contained constraints.

4.3.4 Determining the valence of meaning statements

Additionally, meaning statements were analyzed from their emotional valence. They could be either positive, negative, neutral or ambivalent. Positive meaning statements were considered as an indicator of accepting a service, whereas negative statements pointed to a resistance towards a service. The valence was determined by analyzing whether meaning statements contained keywords with negative or positive connotations, or described positive, negative, or neutral effects, or interviewees expressed a positive or negative attitude towards the service elsewhere. In many cases, a narrow contextual analysis was needed to explicate the emotional valence. Neutral statements often contained non-judgmental propositions. Several reasons were carved out from the data, why a statement was considered as ambivalent:

- The interviewee was in two minds about the 'object' in an inference.
- The statement had both a positive and a negative side.
- The statement was specified to apply to different people with differing valence
- The valence of the statement was simply not clearly expressed.

For example, the sign 'requiring to play around on the smartphone' of the previous meaning statement by Anonymikus had a negative connotation, resulting in the complaint that 'everything will be more electronic', which she emphasized by expressing a negative attitude towards this development in her second conclusion: 'she is not a big fan of it'.

4.3.5 Level of congruence

Based on these MOSC-entities, it was possible to determine the level of congruence between intended and reconstructed meaning statements, which in turn informs the successful transfer of intended meanings (see

research question 2a in Section 4.1). Basically, levels of congruence were determined by analyzing whether users and non-users had developed the same, similar, other (incongruence) or opposing (conflicting incongruence) thoughts behind the MOSC-entities of their reconstructed meanings compared to the thoughts behind the MOSC-entities of intended meanings by designers. Thoughts were considered as similar, when one could be derived from the other. Opposing thoughts were determined by analyzing whether intended and reconstructed meanings involved opposing emotional valences, antonyms or negations [14]. Through that, it was possible to differentiate six different levels of congruence. The following rules for determining these levels were carved out of the empirical data:

- Full congruence was achieved when intended and reconstructed meanings had developed the same thoughts behind their signs, concepts, and meanings as a whole.
- High congruence: intended and reconstructed meanings were considered as highly congruent, when
    - both signs and concepts, or only the concepts covered the same thoughts, or the concepts covered derived thoughts, and the reconstructed meaning was only similar to the intended meaning but not the same, or when
    - intended and reconstructed meanings were the same, and signs or concepts covered the same or derived thoughts, but not both sign and concept.
- Medium congruence: intended and reconstructed meanings were only similar, and the thoughts behind the concepts were not the same, but similar, or the thoughts behind the signs were the same or similar.
- Low congruence was the case, when intended and reconstructed meanings were different, but only the thoughts behind their signs were the same or similar.
- Incongruence: thoughts behind any entity were neither the same nor similar, nor opposing.
- Conflicting incongruence: any thought behind an entity of a reconstructed meaning was opposed to a thought behind any entity of an intended meaning.

At all levels of congruence, the MOSC-entities could also be congruent as a variation, for example the concept of the intended meaning being congruent with the sign of the reconstructed meaning. Such variations occurred for example, when interviewees perceived the idea of the designer, which in turn became the sign, and developed it further by relating it to a new concept. Such chains of thoughts were also described by Peirce (see Section 2.1.1). In such cases at least low level of congruence was achieved, since for both statements at least one idea behind an entity was the same or similar.

It was not possible to determine the level of congruence of some reconstructed meanings, since interviewees drew conclusions about something that was not discussed with the designers of the services. For example, interviewees concluded: about whether a service would be successful or not; about potential improvements by features which were not yet implemented; about requirements; or about users of a service when designers did not mention something about them. Therefore, these meaning statements were coded as 'not applicable' (N.A.) and excluded from the analysis of successful meaning transfer.

> *For example, the meaning statement from above (everything will be more electronic) was conflictingly incongruent with the following intended meaning (M1) by the designer, due to their signs: the designer intended to convey that the web app (object) is 'an obvious and intuitive way to pay and operate self-service laundry equipment (concept)', since it has clear and simple messaging (sign).*

[14] Through this data-driven definition of level of congruence, it is possible to answer a question raised by Crilly et al. (2008): "What determines the level of correspondence between designer intent and consumer response?"

Whereas for the designer the web app has clear messaging, the non-user perceived the requirement to play around on it as negative. In turn, both signs gave rise to very different concepts in order to conclude about different semiotic objects, which were of interest to them.

Furthermore, the meaning statement that 'everything will be more electronic' was also conflictingly incongruent with another intended meaning (M4) due to their concepts: the designer intended to convey that the service (object) is modern (concept), due to electronic payment (sign), whereas the non-user rather complained about this general development in the culture of her country.

Additionally, an exemplary reconstructed meaning is discussed, which was congruent with the following intended meaning on the medium level, in order to show what similar thoughts constituted the medium level of congruence:

When being asked whether the service example b_PSS expresses something about its users, its designer replied that it probably says (sign) that 'users (object) are trying to save money (concept)'. A user (Natalie) of a similar service concluded, when reasoning about the social implications of the service, that 'it (object) might get people out more', since it is more economical to take a bike than taxi or bus (sign). Clearly, the concept of the intended meaning (saving money) became the sign of the reconstructed meaning (more economical). Therefore, the MOSC-entities were not directly congruent, but only as a variation. This variation in the MOSC-entities indicates that the user developed the thought 'saving money' further and derived from it a positive effect.

Intended meaning were considered as **being addressed** in reconstructed meanings, when their level of congruence was either full, high, medium, low or conflictingly incongruent, but not incongruent.

The **successful transfer of intended meaning**, which was called the successful conveyance from the designer's perspective and the successful reconstruction from user's and non-user's perspective, was defined by the levels of full, high, and medium congruence between intended and reconstructed meaning. Medium congruence and higher levels were considered as part of successful meaning transfer, since intended and reconstructed meanings were same or similar. In turn, low congruence, incongruence, and conflicting incongruence were considered as unsuccessful meaning transfer. Incongruent reconstructed meanings were included in the definition, since they were made in response to the interview questions, which aimed at determining the successful transfer of intended meanings. Low congruence was considered as part of unsuccessful meaning transfer, since intended and reconstructed meanings were different.

4.3.6 Linking meaning to aspects of services: the MeaningMap

The identified inferences were further analyzed with regard to which aspects of services were addressed in their MOSC-entities. Categories for these aspects of services were found in the 'PSS layers' by Müller et al. (2009), which were adapted to the needs of the empirical study. Aspects of services included (on level 1) 'processes', 'people', 'technical system', 'context of the service', and 'business model' of the service and were called '**layers'** throughout the thesis. These layers can have different levels of detail, such as interface and infrastructure of the technical system (Secomandi and Snelders, 2011) or the elements of Osterwalder and Pigneur's (2010) business model canvas. In addition to these theory-driven layers, further levels of detail were inductively developed. The whole list of layers can be found in Appendix B. The layers were generic enough in order to be applicable for describing all six service examples, covered in the empirical study. For the statistical tests of independence, only the layers of level 1 were considered due to data constraints. However, more levels of detail were relevant to the qualitative analysis.

Thus, through these layers, the MOSC-entities were linked to the services and they made it possible to analyze the identified inferences and the contained meanings from a design perspective. The links were

established in two ways: either assigning an entity to one or more layers at particular levels of detail, based on its reference to the layers, or the other way around, assigning a layer to an entity, based on its contribution to an entity. In order to facilitate their further analysis, the links between the MOSC-entities and the layers of the services were visualized in a matrix, which was called the '**MeaningMap**'. The two dimensions of the MeaningMap are the identified inferences, deconstructed into their MOSC-entities and the layers of the service. The MeaningMap can be conceived as a three-fold domain-mapping matrix (DMM), one matrix for each MOSC-entity (O, S, C) stacked on each other. Structuring the two dimensions in the MeaningMap, allows researchers and designers to read the map in several ways: analyzing to which layers of services the entities do and do not refer, which entities do and do not contribute to which meanings, and if yes, how many. Thus, both the presence and the absence of links in the MeaningMap are important.

For example, the previously discussed conflictingly incongruent meaning statements by the non-user Anonymikus and the designer of the service example w_PSS can be structured in the following way by first establishing and second mapping the links of their MOSC-entities to the layers of the service in the MeaningMap:

As a reminder, the non-user inferred from the service example that 'everything (object) will be more electronic (concept)' since the web app requires playing around on the smartphone (sign). It was assumed that the interviewee, when mentioning 'everything', referred to a general development in the culture of her country and therefore the entity 'object' can be linked to the layer 'culture' on level 3 of the 'non- or only indirectly influenceable part' (level 2) of the 'context of the service' (level 1). In a similar fashion, the entities 'sign' and 'concept' of the meaning statement can be linked to the layers of the MeaningMap: the web app referred to the layer 'interface' of the 'technical system' on level 1; the requirement to play around on the smartphone referred to the layer 'customer journey', which is part of the layer 'processes' on level 1; the concept 'becoming more electronic' referred to the layer 'other technical systems' (level 3) as part of the 'context of the service' on level 1.

The designer had in mind that the web app (object) is 'an obvious and intuitive way to pay and operate self-service laundry equipment (concept)', since it has clear and simple messaging (sign). Here, the semiotic object was considered as referring to 'one particular part' (level 2) of the 'service as a whole' (level 1), since it was assumed that the designer conceived the web app in its entirety. The essence of the concept was identified as 'a way to pay and operate', which can be linked to the layer 'customer journey', which is part of the layer 'processes' on level 1. Additionally, the attributes 'obvious and intuitive' can be linked to the layer of 'users' (level 3) as 'involved' (level 2) 'people' (level 1), since it must be obvious and intuitive for them. Finally, the essence of the sign 'clear and simple messaging' was messaging and referred to the layer 'interface' of the 'technical system'.

The following table (Table 12) summarizes and visualizes two meaning statements in the MeaningMap.

Table 12: The MeaningMap for two meaning statements about the service example w_PSS

Layers / Meanings		It is an obvious and intuitive way to pay and operate self-service laundry equipment	Everything will be more electronic
Level 1	Level 2		
Service as a whole	As a whole bundle		
	One particular service	O: web app	
Processes	General principles		
	Customer journey	C: a way to pay and operate	S: …play around on smartphone
	Support processes		
People	Involved	C: obvious and intuitive	
	Affected		
Technical system	Interface	S: clear and simple messaging	S: web app requires to…
	Infrastructure		
Context of the service	Directly influenceable		
	Not or only indirectly influenceable		C: more electronic O: everything
Business model	e.g. key resources		

Legend: O: semiotic object
S: sign
C: concept

The MeaningMap and its ways of reading afford the determination of the level of congruence through the map. In specific cases, this endeavor was successful.

> *For example, the designer of the service example b_P2P intended to convey that 'the company (object) ensures that the renter experience is excellent (concept), since every listing is checked manually on plausibility and authenticity (sign).'*

The sign of this intended meaning referred to a very specific layer of the MeaningMap: the support (level 2) processes (level 1) of control (level 3). By checking in the MeaningMap whether reconstructed meanings also referred to this layer, it was possible to determine one part of the successful meaning transfer. The concept of 'excellent renter experience' referred to the layer 'customer journey' (level 2) for bike rental (level 3) as part of 'processes' (level 1). In this case, it was more difficult to determine the level of congruence since the layers were not detailed enough in order to map the idea of an 'experience'. Therefore, for supporting the determination of the level of congruence, the MeaningMap needed to be very detailed, and the meaning statements needed to be very specific.

Another constraint for the application of the MeaningMap is the fact that the same idea can be expressed in many similar ways, but which refer to different layers of the MeaningMap. This was highlighted by reconstructed meanings, despite being fully congruent with an intended meaning, did not always show the same patterns in the MOSC-entities. In fact, 43 % of the signs of reconstructed meanings with full congruence, did not refer to the same layer as the addressed intended meanings.

> *For example, the designer of a 'Multi-service' bike-rental intended through running a café (sign referring to the layer 'service as a whole') that 'people can come along and make it a social activity (concept referring to the layer 'people')'. A non-user (Laretha) addressed this intended meaning, when concluding that 'people with similar interests can connect to one another (concept: 'people')', which was indicated by meeting up there (sign referring to the layer 'technical system' of the 'service space') and drinking coffee (another sign referring to 'processes').*

This reconstructed meaning illustrated the nuances of the café as a sign, whether it was the actual service, the location, or the implied practice. However, for determining the level of congruence, the general idea behind these signs remained the same. Therefore, the MeaningMap did not always facilitate the determination of the level of congruence and therefore in many cases the reconstructed meanings and the thoughts behind their entities needed to be manually compared to all intended meanings of a service example. This does not mean that the MeaningMap is useless. As it will be shown, the MeaningMap still can be used to visualize areas to which users and non-users refer more and less often, and by that derive design requirements for improving the communicative potential of products and services.

4.3.7 The basis of relation between sign and concept

Another determinant of meaning was the basis of relation between the MOSC-entities sign and concept in reference to the object. Its theoretical origin was already discussed in Section 2.1.1., based on which three variables of the determinant were described: similarity, causality, and convention. The following rules for deductively assigning these categories to meaning statements were also based on the theoretical considerations:

- **Similarity**: the sign gives rise to a concept in reference to the object based on similarity when sign and object have a shared quality.
  For example, the relation between sign and concept of the meaning statement - 'everything (object) will be more electronic (concept)', since the web app requires playing around on the smartphone (sign) - was based on similarity: the web app as the sign and 'everything' as semiotic object shared the quality of 'being more electronic', which in turn gave rise to the concept.
- **Causality**: the sign gives rise to a concept in reference to the object based on causality when their relation is based on facts or on the principle of cause-and-effect.
  For example*, a user (Clarissa) concluded about the service example b_P2P (object) that 'it makes cycling more attractive (concept) through making it possible to spontaneously rent bikes (sign)'. The sign and concept of this meaning statement were related through causality, since it is a fact that spontaneity can lead to attractiveness.*
- **Convention**: the sign gives rise to a concept in reference to the object based on convention, when establishing this relation involves rules, habits, or norms, which can be debatable.
  For example, the sign and concept of the previously mentioned intended meaning - that 'the company (object) ensures that the renter experience is excellent (concept), since every listing is checked manually on plausibility and authenticity (sign) - were related through convention, since it involves social norms to determine whether something can be considered as excellent.

4.3.8 Self-referential meaning statements

Meaning statements by users and non-users were also distinguished by whether interviewees referred to themselves or not in order to relate the discussed service examples to themselves. As it is discussed in Chapter 3, such statements can potentially explain user behavior. In case interviewees did not refer to themselves, the statements were called 'general meaning statements'. In order to determine self-referential meaning statements, the statements were analyzed with respect to personal aspects brought into the discussion by the interviewees. These personal aspects could have been whole stories about personal experiences, which were identified in a narrow contextual analysis, or simple keywords such as: '…for me'; 'I can…'; 'it makes me feel…'; 'I like…'. However, it was not enough that interviewees referred to themselves for emphasizing their opinion in phrases such as 'I think that…'.

For example, a non-user (Thore) related the service example w_PSS to himself, when stating that he (object) can have things under control (concept) on his smartphone, since he can track his expenses in the payment history (sign).

4.3.9 Ways of inquiry

The determinant of meaning called 'ways of inquiry' was conceptualized following the ideas of Krippendorff and Butter (2007). They distinguished and defined three categories: **anticipating, observing** and **interfacing** (see Section 2.1.1). It was assumed that users reconstructed their meanings based on their experiences through 'interfacing', and therefore all meaning statements by users were categorized accordingly. As a result, this determinant of meaning was only informative to meaning statements made by non-users. The remaining categories 'anticipating' and 'observing' were assigned by the method of elimination:

1. Meaning statements were analyzed whether non-users were able to observe the objects about which they made their conclusions. If not, they made their meanings through anticipation.
2. If yes, it was further analyzed whether non-users were able to observe the signs. If not, they made their meaning through anticipation. When the conclusion was made about the service, it was additionally checked whether the sign was observable from the provided description of the services. If yes, non-users made their meaning through observation.

The MOSC-entity 'concept' was irrelevant for the analysis, since it is defined as a "cognition produced in the mind" (CP 1.372), and therefore is not observable.

For example, the meaning statement 'everything (object) will be more electronic (concept)', since the web app requires playing around on the smartphone (sign), which was made by a non-user (Anonymikus), was made through observation, since both the MOSC-entities object and the sign of the meaning statement were observable.

4.3.10 Operationalizing the meaning-behavior mechanisms

The conceptualization of meaning-behavior mechanisms can be found in Chapter 3. They were only coded for self-referential meaning statements due to two assumptions: first, it is assumed to be more likely that interviewees actually support meaning statements when they are self-referential rather than general; and second, all meaning-behavior mechanisms involve in some way the self, and it is more likely that interviewees actually mean themselves when making self-referential compared to general meaning statements. However, it could be that cases were concealed in which interviewees used the second person in their explanations so that the interviewer could better empathize with the person in their explanations. The mechanisms were deductively assigned to self-referential meaning statements, based on the following rules:

- Enhancing the self-concept: in the meaning statements, the interviewees related the service to themselves by referring to benefits of the service, through which the service enhances their beliefs about their actual or ideal self.
  For example, a user (Craige) reported that the service w_PSS was very convenient for him, since he had no cash and the service offers cashless payment. It is assumed that the service enhanced his ideal self of not having to carry cash with him all the time.

- Protecting the self-concept: similar to enhancing the self-concept, the adoption, but in this case more often the rejection of a service was expressed through self-protection. This mechanism was applied when interviewees referred in meaning statements to potential threats or risks, which were not consonant with their beliefs about themselves.
  For example, a non-user (James) of the service example w_P2P mentioned that he would check whether a neighbor offered a machine in order to avoid walking around with clothes. In this example,

the image of walking around with clothes was considered as a potential threat to the self-concept of the non-user.

- Relating to others: interviewees' self-referential meaning statements were considered as falling in this category when interviewees referred to others next to themselves.
  For example, a user (Adrian) of the service b_P2P concluded that he is happy to help similar people, when renting out bikes in his hometown.
- Relating to the past: this category was assigned when interviewees reported their experiences, based on which they related the service to themselves. For that, meaning statements were explicated by a narrow context analysis.
  For example, a non-user (Selina) of the service example w_PSS inferred from the service that she can walk in anytime, after having reported her experience with another laundromat which had limited opening hours.
- Adaptive attitude: when interviewees reported a change in their perception or in their environment such as a technological advancement, to which they mentioned to have adapted, it was assumed that interviewees have formed an adaptive attitude towards this change.
  For example, a user (Craige) of the service w_PSS mentioned that many people may be scared using online payment in general, but he was not. In this example, 'online payment' was considered as a change in the user's environment.
- Motivational quality: this category was applied when interviewees related the service to themselves when anticipating or reporting its use for the sole reward of being engaged in its use, such as out of curiosity.
  For example, a non-user (Chico) of the service example w_MS concluded that she would still go there to check out this 'museum' (due to its retro styling) even though she did not need to wash.

4.3.11 Considering inferred intentions and thoughts by others

Two interview questions prompted interviewees to think in a special way. One was to i**nfer the intention of designers**, and the other was to **imagine what their peers would think about them**. The meaning statements contained in the direct answers to these questions were coded accordingly: 'being prompted to infer the intention of designers' and 'thoughts by others'. Responses, which obviously did not address these questions were coded in the same manner as responses to all other questions: 'not being prompted to infer the intention of designers' and 'thoughts by the interviewee'. However, in some cases, interviewees also reported thoughts by others, including designers, without being prompted to do so.

> *For example, the researcher asked: "do you think of any positive or negative social implications that could come with such a place?" A user replied: "I was just thinking that, you know, people that don't use a laundromat may think that people who do are poor, have less money."*

Clearly, the user referred to other people's thoughts. Therefore, not only meaning statements responding to interview questions, by which interviewees were prompted to report thoughts by others, but also all meaning statements were checked whether interviewees inferred the intention of designers or reported thoughts by others.

4.3.12 Reliability

The inter-rater reliability was assessed, since objective and reproducible coding of the interview data, i.e. deductively assigning categories (see Section 4.3.1), is crucial for the reliability of the results from the statistical analysis of the coded interview data. For that, two judges, one Master student in Engineering and

one PhD candidate in social sciences, coded the interview data of ten randomly chosen meaning statements out of the total of 771 meaning statements. The judges were asked to identify the inferences the interviewees made and to deconstruct each inference into its entities. These two steps of coding were done in conjunction, since they can influence each other, but analyzed separately. Their coding were compared to the coding of the researcher, who developed the analytical procedure and coded all 771 meaning statements in order to determine the agreement between all three raters, i.e. the judges and the researcher, and calculate Krippendorff's alpha (Krippendorff, 2004), as the measure of inter-rater reliability. Krippendorff's alpha was chosen, since it is applicable to more than two raters, to nominal data and to cases in which raters did not assign a category (missing data).

In preparation for making the comparisons, the judges received a 15 min introduction into the topic by the researcher. Then the judges could gain first experience by coding eight exemplary meaning statements, for which they spent 15 min. This was followed by 30 min Q&A. After a short break, the judges worked for 45 min on the ten meaning statements for the assessment of the inter-rater reliability. The judges were supported by four worksheets including the indicating words for premises and conclusions, the analytical procedure involving the MOSC-entities, and the guiding questions. This support material was developed by the researcher, who also applied it for coding all interview data. The judges could either highlight the identified inferences in the text of the provided interview data or write it on a separate worksheet. Additionally, they were asked to write down the MOSC-entities of each deconstructed inference. By that, the researcher was able to analyze whether the same or different sections of the interview data were assigned in which an inference was made, and whether the same or different key words were identified as entities of an inference. In total, the inter-rater reliability was computable for four variables: the identified inference, and its entities concept, object and sign. Finally, the coding was discussed in order to collect feedback.

> As it turned out, the levels of inter-rater reliability (Krippendorff's alpha) were 0.823 for identifying inferences, and 0.383, 0.911, 0.853 for deconstructing each inference into its parts: object, sign, concept [15].

It is striking that all levels, except for 'object', are above the threshold of 0.8 for calling the coding reliable (cf. Krippendorff, 2004, p. 241). The two judges reported in the discussion after the coding that the provided context of the statements was very limiting for them. Since the 'object' was defined as the reference point of an inference, about which a conclusion is made, it is assumed that the limiting context is a possible explanation for the low level of agreement on it. The interview data of the ten randomly chosen meaning statements was reduced in order to avoid that the judges identify additional inferences which could distract or confuse them. The reduction of the interview data was especially difficult in case of convoluted inferences. Therefore, it is concluded that whole sections of interview data need to be provided for the next assessment of inter-rater reliability and all contained inferences discussed. Another explanation for the low level of agreement on the 'object' is that it is arguable what was of interest for the interviewee in the meaning statements: for example, one non-user concluded that young people could use the service w_P2P for fun (concept), since they are bored in normal laundromats (sign). Now, the question is raised: what was of more interest to the interviewee: "young people" (using the platform for fun) or "the platform" (is used for fun)? One could argue that since the sign also referred to young people, the interviewee as more interested in the young people than the platform.

[15] For the calculation of Krippendorff's alpha, a free web tool was used, which was developed by Freelon (2013).

In response to that, another assessment was run, which involved 1.5 h of introduction and training for one unexperienced judge, i.e. double the time of the previous assessment. Additionally, improved worksheets and guidelines were provided, including more detailed rules, and a visual support by the meaning triangle, which supported the judge in the same procedure as in the first assessment. The judge worked for 1 h on six meaning statements, but only fully coded five of them.

> As it turned out, the levels of inter-rater reliability (Krippendorff's alpha) were 0.8 for identifying inferences, and 0.571, 1.0, 0.82 for deconstructing each inference into its parts: object, sign, and concept.

It can be concluded that the increase efforts on training and support paid off, since the agreement on 'object' increased. Still, it is far from perfect, however pointing into the right direction, so that it is assumed that the agreement would increase with more experience. Thus, this low agreement on the 'object' highlights the limits of the research method: first, it requires much training, and second, is very time-consuming.

Based on these levels of inter-rater reliability, results from the statistical tests of independence involving the entity 'object' need to be critically questioned.

In comparison to a former application of the same analytical procedure with seven judges, which was already reported elsewhere (Waltersdorfer et al., 2017), the two judges coded more meaning statements in the same amount of time and reached higher levels of agreement with the same time spent on training. It is assumed that the smaller number of judges, two instead of seven, and the refined support material were beneficial conditions for its successful application. In any case, the inter-rater reliability assessment showed once more that the analytical procedure can be taught, comprehended and applied within a few hours, and can deliver good results.

Chapter 5 Empirical findings

In this chapter, the results of the statistical analysis of the qualitatively analyzed meaning statements are reported, illustrated by examples, and discussed. Additionally, results of the qualitative analysis of meaning statements are reported and discussed. Both quantitative and qualitative results are sorted by research questions and common themes in the chapter's sections.

For better readability, the results are directly discussed after having been reported. In order to strengthen the separation of results and discussion visually,

the results are reported in paragraphs with increased indent.

Additionally, **conditions of correlations are signified in bold** and *illustrative examples of meaning statements are marked in italic*. The discussion is formatted as a normal paragraph.

Figure 5 summarizes the number of meaning statements per interviewee and the number of interviewees, which contributed to the discussion of the sharing types per shared good. The whiskers of the boxes indicate the minima and maxima of the data. Note that the number of interviewees cannot be summated, since each interviewee contributed to the discussion of more than one service. The figure shows that some interviewees were more talkative than others about certain service examples. One reason for the slightly higher averages and median of meaning statements about services with involve washer could be that more German-speaking users and non-users were interviewed about this shared good, and by that it was easier to build rapport.

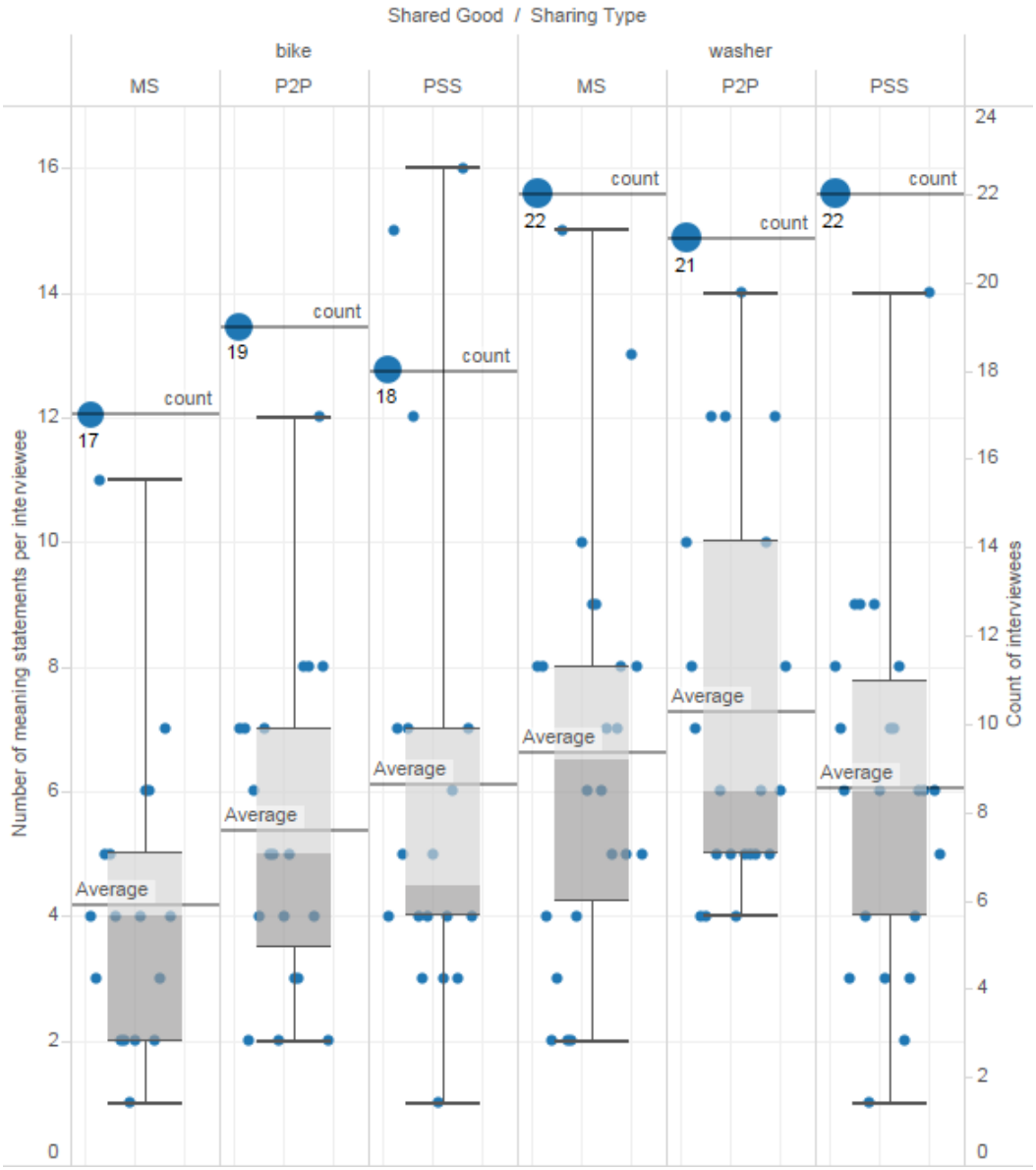

Figure 5: Boxplot of the number of meaning statements per interviewee (left scale) and the count of interviewees (right scale) per sharing type and shared good

As Figure 6 summarizes, 771 meaning statements were analyzed in total, following the procedure described in Section 4.3.1. Several meaning statements needed to be excluded from further analyses on many occasions:

- meaning statements by designers, in case only those of users and non-users were analyzed;
- meaning statements about other services, which were defined as those services of which no designer was interviewed. This was relevant when analyzing the successful reconstruction of intended meanings.
- Meaning statements whose level of congruence could not be determined, since interviewees drew conclusions about something that was not discussed with the designers of the services. This was also relevant to the analysis of the successful reconstruction of intended meanings.
- Finally, in case only interviewees' own thoughts were interesting, also those meaning statements needed to be excluded, in which thoughts by other persons were reported.

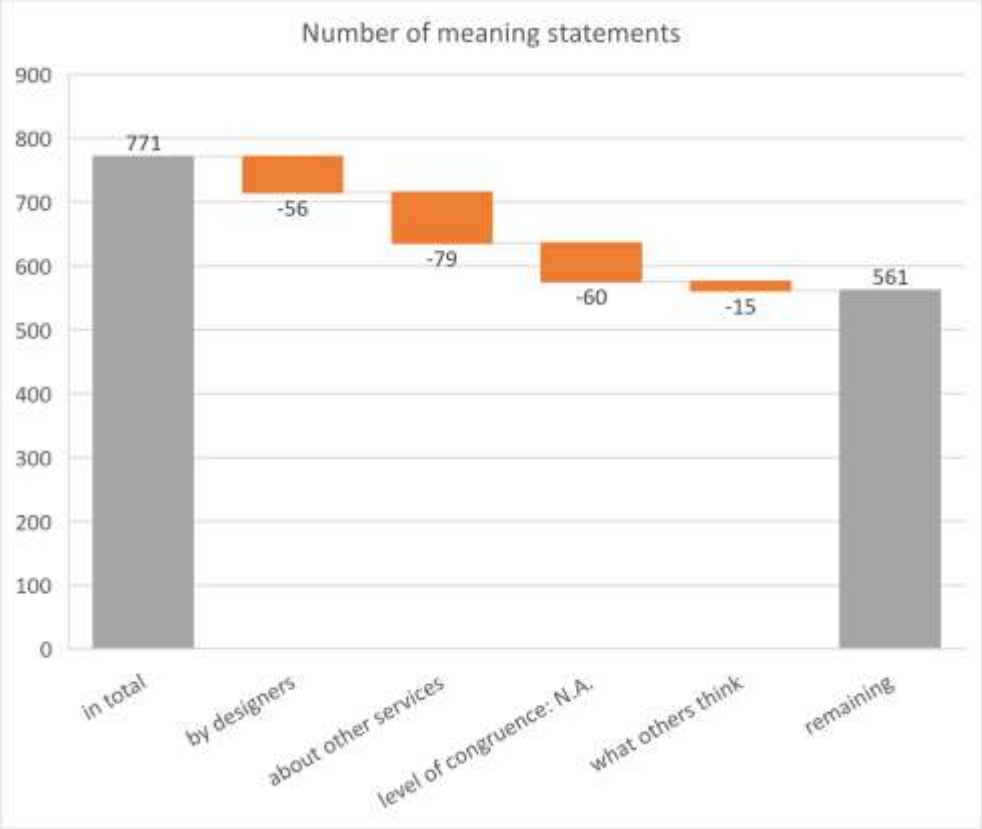

Figure 6: Number of total meaning statements, and those, which needed to be excluded from most statistical analyses

An overview of all tested correlations, which will be reported in the following, and their contingency tables can be found in Appendix C.

5.1 The influence of interview questions

As mentioned in Section 4.1.2 on the method of the empirical study, interviewees were prompted to infer the intention of designers in one question of the semi-structured interview, which was also considered during coding. Of course, they could have inferred the intention of designers on other occasions as well, which remained unobserved. Nevertheless, as the following results indicate, the interview question prompting interviewees to infer the intention of designers influenced some determinants of the meaning statements.

> When interviewees were prompted to infer the intentions of designers, they showed more often higher levels of congruence (for each single level: full/high/medium level of congruence) than when they were not prompted to infer the intentions ($p=1.3E-12$; $chi^2=64.7$; $df=5$; $N=554$; Cramer's $V=0.34$).

It is assumed that prompting interviewees to infer the designers' intention made the interviewees aware about the communicative character of the services and directed their attention on the designers instead of the service. Since prompting interviewees to infer the designers' intention had an influence on the level of congruence, it should be handled with care in future analyses.

> Additionally, when interviewees were prompted to infer the intentions of designers, they more often did not make self-referential meaning statements than when they were not prompted to infer the intention ($p=2.2E-07$; $chi^2=26.9$; $df=1$; $N=605$; Cramer's $V=0.21$). Thus, prompting interviewees to infer the intention of designers led to significantly more general than self-referential meaning statements.

It is assumed that interviewees, when being prompted to infer the intention of designers by an interview question, formulated their meaning statements more often in general terms than referring to themselves, since they wanted to make a statement, which was widely applicable.

> When interviewees were prompted to infer the intentions of designers, they responded more often with meaning statements with positive or neutral and ambivalent than negative valence compared to interview questions, in which they were not prompted to infer the intention ($p=5.2E-08$; $chi^2=33.5$; $df=2$; $N=554$; Cramer's $V=0.25$).

It is assumed that interviewees supposed that designers only had good intentions, since none of the interviewees' meaning statements showed a negative valence.

> Interestingly, there was one meaning statement responding the question on the designers' intention, which was ambivalent:
>
> *when being asked what message the service example w_PSS is trying to convey, a non-user (Klaus) responded that 'it (object) is trying to catch up with technology (concept)', since it now offers a web app (sign).*
>
> The statement was considered as ambivalent, since its positive connotation of 'catching up' also implies a negative connotation of 'being late', but still supposed good intentions by designers.

The following sections take up the influence of the interview question on the level of congruence, self-referential meaning statements, and the valence of meaning statements, which has just been described.

5.2 The successful transfer of intended meaning

The aim of the analysis was to identify determinants of meanings and other factors, which contribute to the successful transfer of intended meaning (RQ 2a). The levels of congruence between intended meaning by designers and reconstructed meanings by users and non-users was the dependent variable for analyzing the successful transfer of intended meanings. The transfer of intended meanings was considered as successful, when reconstructed meanings reached the levels of full, high, and medium congruence. In turn, the levels of low congruence, incongruence, and conflicting incongruence were not considered as successful transfer. The term 'successful conveyance' designates the designer's perspective, whereas the term 'successful reconstruction' designates the user's or non-user's perspective on the meaning transfer.

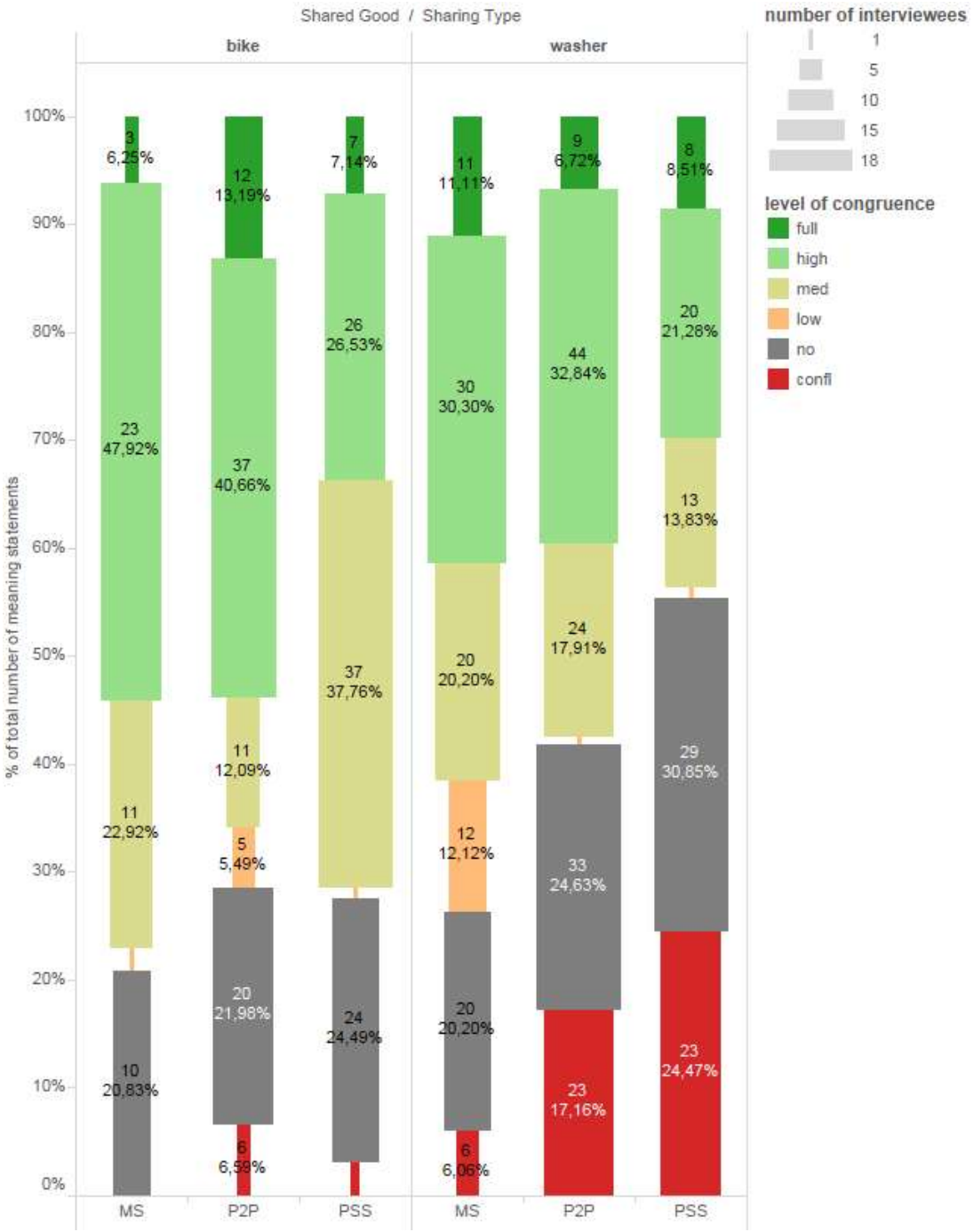

Figure 7: Percent (height) of and total number of meaning statements per level of congruence (color) per service example, specified by the number of interviewees (width)

In order to provide an overview on the service examples, Figure 7 distinguishes the number of meaning statements, made by non-users and users, by their level of congruence. It shows that the services w_P2P and w_PSS were the most controversial and the service example b_MS the least controversial studied service examples. The width of the bars represents the number of interviewees per category and therefore indicates that for example the many conflictingly incongruent meaning statements are not based on the opinion of a few interviewees.

5.2.1 Self-referential meaning statements

First, the relation between self-referential meaning statements and the successful reconstruction of intended meanings was analyzed.

> As it turned out, self-referential meaning statements by either users or non-users significantly more often did not successfully reconstruct any intended meaning than general meaning statements. For users the values of the statistical test were: p=0.042; chi²=4.1; df=1; N=129; Cramer's V=0.18. For non-users the values were: p=0.034; chi²=4.5; df=1; N=432; Cramer's V=0.1.
>
> Having in mind, that prompting interviewees to infer the intention of designers resulted in more general than self-referential meaning statements, the analysis of the relation between self-referential meaning statements and the successful reconstruction of intended meanings was also executed for meaning statements, which responded to interview questions through which **interviewees were not prompted to infer the intention of designers**. As it turned out, no correlation was found. For users the values of the statistical tests were: p=0.65; chi²=0.2; df=1; N=86. For non-users the values were: p=0.23; chi²=1.4; df=1; N=328.

Therefore, it is assumed, when the interviewing researcher did not intervene in the reconstruction of meaning by prompting the interviewees to infer the intention of designers, self-referential meaning statements did not inform the successful reconstruction of intended meaning.

> However, **when analyzing the relation for the service example w_P2P**, it turned out that non-users, when not being prompted to infer the intention of designers, more often successfully reconstructed intended meanings in general meaning statements than in self-referential meaning statements (p=0.025; chi²=5.0; df=1; N=103; Cramer's V=0.22).
>
> The meaning statements by non-users about the service w_P2P were further analyzed from the perspective of their **MOSC-entities and their references to the layers of the MeaningMap**. The analysis showed that only the entity 'object' referring to the layer 'people', supported the correlation between general meaning statements and the successful reconstruction of intended meanings by non-users, when they were not prompted to infer the intention of designers (p=0.028; Fisher's exact test, two-tailed; df=1; N=41; Cramer's V=0.36).
>
> *For example, a non-user (James) inferred from interacting with and making the connection with the owner of a washer (sign) that you (MOSC-entity 'object' referring to the layer 'people') become part of your local community (concept). He successfully reconstructed the designers' intention (**M1** about **w_P2P**) 'to create relationships among people' and expressed this meaning statement in general terms. In contrast, another non-user (Gigi) referred to herself, when concluding that she ('object' referring to 'people') would feel uncomfortable (concept) when she was going to a stranger's home (sign) for doing the laundry.*

It is assumed that non-users more often successfully reconstructed intended meanings, because they did not relate the service to them in self-referential meaning statements, but made general meaning statements, which were often non-judgmental. For example, James mentioned another sharing service through which he already became part of a community. 78% of the self-referential meaning statements, in which no intended meaning was successfully reconstructed, were negative. Therefore, it is further assumed that non-users felt the urge to distant themselves from the service, for example when imaging to use the service, such as Gigi in the example above.

The results imply for design that designers could already check during the simulation and evaluation phases whether their intended meanings are successfully reconstructed in self-referential meaning statements by potential users or not. It could be a warning signal when the intentions are not successfully reconstructed in self-referential meaning statements. In case of successful reconstruction, these meaning statements could identify specific user groups and could also assure designers that their intended meanings have the potential to be internalized. Additionally, more detailed levels of the MeaningMap for the layer 'people' could facilitate the analysis who is actually addressed in the references to it.

In summarizing the whole section about the relation between self-referential meaning statements and the successful reconstruction of intended meanings, it can be concluded that the correlation only applied to very specific conditions. For the service example w_P2P, designers were only able to successfully convey their intentions when non-users did not refer to themselves in their meaning statements. Rather, non-users found other unintended self-referential meanings, which were mostly negative.

5.2.2 Users and non-users

Users successfully reconstructed intended meanings significantly more often than non-users. This correlation was found for all three service examples with best data for comparing users and non-users:

- w_MS ($p=0.003$; $chi^2=8.$; $df=1$; $N=99$; Cramer's $V=0.29$)
- b_P2P ($p=0.047$; $chi^2=3.9$; $df=1$; $N=92$; Cramer's $V=0.21$)
- b_PSS ($p=0.044$; $chi^2=4.1$; $df=1$; $N=98$; Cramer's $V=0.2$)

Possible explanations could be that users were more successful in reconstructing intended meanings due to their experience with the service. Alternatively, it could also be that users adopted the service, since they understood what designers wanted to convey.

When analyzing **MOSC-entities and their reference to layers of the MeaningMap** of **single service examples**, it turned out that the correlation between successful transfer of meaning and use only applied to b_PSS. For this service example, users successfully reconstructed significantly more often intended meanings than non-users when referring to its 'technical system' during perception (=sign), whereas non-users reconstructed significantly more often meanings, which were not intended by designers. ($p= 0.0097$; Fisher's exact test, two-tailed; $df=1$; $N=20$; Cramer's $V=0.62$).

*For example, a user (Paul) of the service example **b_PSS** concluded that 'it is always right there, when I want to ride'. He is constantly reminded about that when coming across his personal access token to the bike sharing system in his pocket. In this example, the token, which is part of the technical system of the whole service, acted as a sign during perception and evoked the idea (concept) of 'being always right there', which referred to the service as a whole (object). This meaning was to a high level congruent with the intended meaning (**M5**) 'it (object) is a speedy and flexible mode to get around in the city (concept) since it is on-demand (sign)' because the user addressed the sign of the intended meaning and uses it as the concept for deriving a similar meaning.*

On the contrary, another exemplary meaning statement was not congruent with any intended meaning by the designer of b_PSS: a non-user (ee39) concluded during the interview, when recognizing on the description of the service that all bikes look the same, that 'it (object) is very sociable (concept)', since it allows users to make group rides with the same kind of bikes (sign). In this example, the sign referred again to the layer 'technical system' of the MeaningMap.

In the first example, the advantage of the service example ('being always right there') needs to be experienced or observed. This might be a reason, why it was difficult for non-users to reconstruct a similar

meaning. The second example shows that the service can afford unintended practices, which can be either desired or undesired.

Paul's statement can be interpreted as a confirmation for designers that the system works as intended, i.e. on-demand. Further, the access token acted as a small representation of the service, which designers of other services can consider for making them more tangible. Designers can also use the meaning-based approach to design-as-communication to analyze affordances captured during the simulation phase. These analyses may support their explorations whether they can strengthen or weaken the communicative potential of each affordance, and if yes, in what way. In case the service provider decides to foster group rides in order to strengthen communities and to increase the number of rentals, designers could, for example (only some ideas off the top of my head), make group memberships possible, enhance the phone app with a group ride scheduling assistant, or plan cycling events on weekends where users can invite friends to ride for free.

As the meaning statement examples illustrate, perceiving the 'technical system' of a service can lead to many different inferences, which, in case of non-users compared to users, significantly more often do not successfully reconstruct the intended meanings. This correlation lives up to the expectation that successful reconstruction is facilitated through experiencing the service as a user. Since the correlation between use and the successful reconstruction of intended meanings was only found on the level of MOSC-entities referring to layers of the MeaningMap for the service example b_PSS, it is assumed that the 'technical system' of this service was especially relevant for the successful transfer of intended meanings to users.

5.2.3 Valence

All intended meanings were positive or neutral. Since the successful transfer of intended meanings was determined by whether user and non-users developed same or similar thoughts behind their meaning statements, intended meanings could not be successfully reconstructed in meaning statements with negative valence. Therefore, the valence of reconstructed meanings did not contribute to the quantitative analysis of successfully conveyed intended meanings.

However, differentiating meaning statements, which did not successfully reconstruct intended meanings by their valence yielded interesting cases, which are discussed in following sections: first, conflictingly incongruent meanings with positive valence (Section 5.2.8.2: w_PSS M8); second, incongruent (conflicting or not conflicting) meanings with negative valence (Section 5.3); and third, incongruent (only not conflicting) meanings with positive or neutral valence (Section 5.4). It is expected that design improvements of the services can be derived from these cases.

5.2.4 Ways of inquiry by non-users

No correlation was found between non-users' ways of inquiry for making meaning and the successful reconstruction of intended meanings, neither **for single service examples, nor for all services taken together** ($p=0.404$; $chi^2=0.7$; $df=1$; $N=434$).

5.2.5 Basis of relation between sign and concept of reconstructed meanings

The successful reconstruction of intended meanings was dependent on the basis of relation between sign and concept of reconstructed meanings when all service examples were taken together for the analysis ($p=0.002$; $chi^2=9.8$; $df=1$; $N=538$; Cramer's $V=0.14$). Reconstructed meanings relating their signs and concepts through 'causality' showed more often than not full, high, or medium congruence

with intended meanings. The opposite was true for reconstructed meanings relating their signs and concepts based on 'convention': in these meaning statements, intended meanings were less often successfully reconstructed. The third basis of relation called 'similarity' was left out of analysis due to its low number of occurrence: only 4% (22 out of 560) meaning statements by users or non-users about the covered services were considered as relating their signs and concepts through similarity. No difference was found between users and non-users. The values of the statistical tests were for users: p=0.017; chi²=5.7; df=1; N=127; Cramer's V=0.21 and for non-users: p=0.014; chi²=6.1; df=1; N=411; Cramer's V=0.12).

However, the correlation between the basis of S-C relation and the successful reconstruction of intended meanings only persisted when **interviewees were not prompted to infer the intention** of designers (p=0.0003; chi²=13.2; df=1; N=394; Cramer's V=0.18). For this analysis, all service examples were taken together.

It is assumed the direction of influence between the two variables points from the basis of relation to the successful reconstruction of intended meanings by users and non-users. It is further assumed that their reliance on causality led more often to a successful reconstruction of intended meanings, since causal relations are less controversial than conventional relations are. Lastly, it is assumed that users and non-users most often do not infer the intention of designers in their daily lives but start for their meaning making directly from the product or service, except a product or service is disturbing. Therefore, it is assumed that the condition of not being prompted to infer the intention of designers comes close to the situation in practice and makes the correlation between the successful reconstruction of intended meanings and the basis of S-C relation in meaning statements applicable to practice.

When analyzing single service examples, the correlation between successful reconstruction of intended meanings and basis of S-C relation was observed for b_PSS and w_P2P, but not for the remaining four service examples. (p=0.024; chi²=5.1; df=1; N=126; Cramer's V=0.2). **Interviewees were not prompted to infer the intention of designers**.

- b_PSS (p=0.013; chi²=6.2; df=1; N=96; Cramer's V=0.25)
- w_P2P (p=0.024; chi²=5.1; df=1; N=126; Cramer's V=0.2)

*For example, the designer of the service **w_P2P** intended to convey the meaning (**M5**) that 'you (object) can find a washer which is close (concept) due to high number of listed washers (sign)'. This intention was only addressed by reconstructed meanings with full or high congruence (in total: 11).*

This fact raises the question, why this intended meaning was so often successfully reconstructed, especially since this service example was the second most controversial among all six covered service examples with 15,8% of all reconstructed meanings being in conflict with one of the other five intended meanings. One reason might be that nine out of these 11 reconstructed meanings based their S-C relations on causality.

These nine meanings all perceived the nearby washer as a sign from which they inferred, for example, that users 'just need to pop down a few houses', or that 'they don't have to drive ages to a laundromat', or that the service 'is about optimizing distances and time'. In these cases, the washer, which is close, was easily perceivable though a map on the website showing many available washers.

In the two remaining reconstructed meanings, whose signs and concepts were related through convention, non-users conclude about the service that it is a convenient alternative to normal laundromats due to the washers' proximity. Since one can argue whether to label something as convenient, the meanings' S-C relations were considered to be based on convention.

It is assumed that users and non-users were able to relate signs and concepts through causality, and in turn successfully reconstructed intended meanings, since the signs were easily perceivable and easily to relate to concepts based on facts, which underlay causal relations.

Therefore, designers could check during synthesis and simulation how visible the signs of their intended meanings are and whether they can be related to concepts based on facts.

When analyzing the correlation between the successful reconstruction of intended meanings and the basis of S-C relations of reconstructed meanings from the perspective of **MOSC-entities and their reference to the layers of the MeaningMap for single service examples**, the following specifics were found: the correlation only stood for meaning statements made by users and non-users about the services b_PSS and w_P2P, whose concepts referred to the layer 'people' and whose signs referred to 'processes'. **Interviewees were not prompted to infer the intention of designers,** except for meaning statements about the service b_PSS, whose signs referred to 'processes'

- For b_PSS:
  - Concept referring to 'people': p=0.005; chi²=7.8; df=1; N=37; Cramer's V=0.46
  - Sign referring to 'processes': p=0.033; Fisher's exact test, two-tailed; df=1; N=34; Cramer's V=0.44
- For w_P2P:
  - Concept referring to 'people': p= 0.01; chi²=6.6; df=1; N=54; Cramer's V=0.35
  - Sign referring to 'processes': p= 0.004; chi²=8.3; df=1; N=43; Cramer's V=0.44

*For example, the designers of **b_PSS** intended to convey that (**M6**) 'users are trying to be fit and healthy by using our service (which involves cycling)'. Reconstructed meanings by users and non-users, which showed high levels of congruence, revolved around the concept 'health', which refers to the layer 'people'. In many of these meanings, the idea of health was extrapolated to conclude, for example, about the city, becoming a healthier environment, or employers, benefiting from healthy employees, or the service as a healthy alternative to the metro. Some of these meanings additionally covered perceptual cues (signs), such as 'exercising' and 'getting people cycling', which refer to the layer 'processes'. Also, the intended meaning's sign referred to the layer 'processes' ('cycling') and the concept to the layer 'people' ('being fit and healthy') and both being related through causality.*

It is no surprise that in these examples the signs and concepts of both intended and reconstructed meanings addressed the same layers of the MeaningMap since the level of congruence was determined by comparing the thoughts behind their MOSC-entities. However, as mentioned before, this is not always the rule since thoughts can also be expressed in many different ways.

Besides the MOSC-entities referring to the same layers, it is also striking that signs and concepts of intended and reconstructed meanings were both related through causality. It is hypothesized that the bases of S-C relations of intended meanings facilitate their successful reconstruction by users and non-users.

5.2.6 The basis of relation between sign and concept of intended meanings

In order to test the hypothesis, which was constructed in the previous section, it must be shown, if first, the bases of S-C relations, appearing in both intended and reconstructed meanings, were significantly correlated and second, they were further correlated with the successful conveyance of intended meanings.

Whether these conditions were met could only be determined when users and non-users addressed a specific intended meaning by developing same or similar thoughts behind an entity of the intended meaning. Thus,

reconstructed meanings, which were not congruent with any intended meaning, were left out of the following analysis.

First, it was analyzed, whether reconstructed meanings had significantly more often the same basis of S-C relation as the addressed intended meaning, than the other basis of S-C relation.

> As it turned out, the basis of S-C relation of reconstructed meanings was significantly correlated with the same basis of the intended meaning (p= 0.016; chi²=5.8; df=1; N=423; Cramer's V=0.12). In other words, when the relation of sign and concept of a specific intended meaning was based on causality, then the S-C relations of reconstructed meanings were also more often based on causality than on convention. The same was true when the S-C relation of the intended meaning was based on convention.
>
> Additionally, from the perspective of every single intended meaning of each service example, it turned out that for 29 intended meanings, reconstructed meanings showed more or equally often the same basis of S-C relation than not, and only for 13 intended meanings reconstructed meanings showed more often the other basis of S-C relation.

Second, it was analyzed, whether the basis of S-C relation, being the same for intended and reconstructed meaning, was correlated with the successful conveyance of the intention.

> **Intended meanings, which S-C relations were based on causality**, were significantly more often successfully conveyed, when S-C relations in reconstructed meanings were also based on causality and not on convention (p=0.03; chi²=4.7; df=1; N=237; Cramer's V=0.14).
>
> However, **when designers related signs and concepts of their intended meanings through convention**, their intentions were more often successfully conveyed, when users and non-users used causality and not convention as the basis of S-C relation during the reconstruction of these intended meanings (p=0.041; chi²=4.2; df=1; N=186; Cramer's V=0.15).

Therefore, it is concluded that only causality as the basis of S-C relation of an intended meaning facilitates its successful conveyance.

> The successful conveyance of intended meanings, when both intended and reconstructed meanings were based on causality, was also shown **when analyzing non-users only**, (p=0.034; chi²=4.5; df=1; N=189; Cramer's V=0.15) but not for users (p=1; Fisher's exact test, two-tailed, df=1, N=48). It needs to be mentioned regarding users that only two meaning statements were observed in this analysis, in which they did not successfully reconstruct an intended meaning.
>
> *The service example **w_P2P** was very controversial, expressed in many conflictingly incongruent reconstructed meanings. However, as the following example illustrates, some intended meanings, whose S-C relations were based on causality, were also successfully conveyed. The designers intended (**M3**) to 'help people without washing machine' (concept) through their platform (object) by matching supply and demand (sign). In this example, the sign and concept were in a causal relationship based on the idea that the matching could already be considered as some help.*

It is assumed that this relation provided the condition for the successful conveyance of the intended meaning.

> *Two non-users (Dehia, Sabrina) addressed the designer's intention when concluding that 'it [the idea behind the service] (concept) is about helping others (object)', since it involves sharing (sign), whereby 'one (object) does not need to go to a laundromat (concept)' anymore.*

In both reconstructed meanings, the S-C relations were based on causality, since, in the first example, the sign 'sharing' gave rise to the concept of the 'service', based on the fact that it is an essential part of its

business model, and in the second example, the cause 'sharing' affected the users in how they can do their laundry.

It might be obvious to the reader that the service provider wanted to help, however, as the only meaning statement, which was in conflict with the intention, revealed, the service could be interpreted differently:

> *A non-user (Sascha) concluded that 'it [the idea behind this service] (concept) is about making business' (object), since the lister of the washer determines the price (sign).*

In this example, sign and concept were related through convention since one can argue whether 'listers determining the price' was an essential part of the concept 'service'. This meaning statement highlighted that it also depended on the listers, offering their washers on the platform, and their behavior, how the service was interpreted. For example, the listers could also take advantage of people without washers and stretch the boundaries of when the service could be considered as help.

> *Contrarily, another non-user (Anonymikus) inferred from comparing costs and benefits for listers (sign) that 'they (object) cannot earn a lot of money (concept)'.*

These examples highlight the following: designers could introduce rules for pricing and renting, so that no party can take advantage of its position, and the platform stays attractive for both parties. Moreover, these rules could be made explicit in order to facilitate the successful conveyance of the intended concept of 'helping', as opposed to 'making business'.

The example of intended meaning illustrated, how its S-C relation based on causality could be a condition for its successful conveyance, when non-users and users apply the same basis of S-C relation during reconstruction.

Therefore, it is recommended to designers to strive for causality as a basis of S-C relation if possible in order to provide the best conditions for successfully conveying their intentions.

5.2.7 Congruent or conflicting MOSC-entities

Another way of analyzing the successful transfer of intended meanings is to compare whether signs, concepts or both entities of reconstructed meanings were either more often congruent or conflictingly incongruent with the entities of the addressed intended meaning.

> When signs and concepts of reconstructed meanings were related through causality in comparison to convention, their concepts were significantly more often congruent than conflictingly incongruent with concepts of addressed intended meanings. In turn, when the relations between signs and concepts were based on convention, the concepts of reconstructed meanings were more often conflictingly incongruent than congruent with the concepts of the addressed intended meanings ($p=0.002$; $chi^2=9.3$; $df=1$; $N=112$; Cramer's $V=0.29$).
>
> This correlation could neither be shown for signs ($p=0.53$; Fisher's exact test, two-tailed, $df=1$, $N=61$) nor both concepts and signs ($p=0.4$; Fisher's exact test, two-tailed, $df=1$, $N=54$).
>
> *For example, one non-user (Paul) of b_P2P anticipated that meeting the owners of bikes and shaking hands with them (signs) imply that renting is a 'commitment' (concept referring to the layer 'people' in the MeaningMap). The S-C relation is based on convention since it depends on social norms whether it can be considered as a commitment. This concept is conflicting with the designer's intention (**M4**) about the service **b_P2P**, who tried to evoke a 'community aspect' (concept: 'people') through the same signs.*

It is assumed that the personal contact with private persons when renting bikes might be unfamiliar for many people who are rather used to do business with companies. Therefore, the concept of commitment can be considered as a negative side effect for this particular non-user. The service designer could respond to such concerns by making the rental agreement and the commitment to it more explicit before use, so that it can be observed and in turn, owners do not need to enforce commitment through token gestures.

Additionally, **when designers based the relation between signs and concepts of their intended meanings on causality**, concepts of reconstructed meanings were more often congruent than conflicting with concepts of intended meanings, when relations between signs and concepts of reconstructed meanings were also based on causality. In turn, concepts of reconstructed meanings were more often conflictingly incongruent when users and non-users, in contrast to designers, related signs and concepts based on convention (p=0.032; Fisher's exact test, two-tailed; df=1; N=56; Cramer's V=0.31).

Also, this correlation could neither be shown for signs (p=0.69; Fisher's exact test, two-tailed, df=1, N=35) nor both concepts and signs as congruent or conflictingly incongruent entities (p=0.28; Fisher's exact test, two-tailed, df=1, N=32)

When designers based the relation between signs and concepts of their intended meanings on convention, no correlation was found between congruent or conflictingly incongruent concepts and the relations between signs and concepts of reconstructed meanings (p=0.093; chi^2=2.8; df=1; N=57).

*For example, the relation between signs and concept of the intended meaning (**M4**) of the service example **w_P2P** 'it (object) is a win-win service (concept), since people listing their washers get a small income and renters can save money (signs)" was based on causality, since the signs were facts.*

For example, two non-users (David, Matthieu) referred to similar concepts, which were therefore considered as congruent with the concept of the above-mentioned intended meaning (M4). David concluded that students (object) can earn some extra money (concept) through listing their washers (sign). Matthieu thought about the renter when concluding that it (object) is a cheap alternative (concept), since one does not have to buy or own a washer (sign).

In contrast, another non-user (11) inferred from people saving money by going to someone else's house for doing laundry (signs) that they (object) probably come from a lower socio-economic background (concept).

In the first two meaning statements by non-users, signs and concepts were considered as being related through causality, since the signs were facts. The third reconstructed meaning addressed the intended meaning's sign, but its concept had a negative connotation which was not intended by the designers and was therefore considered as conflictingly incongruent. In fact, the designers aimed at helping young people. Whether someone using the washer of someone else can be considered as coming from a lower socio-economic background depends on the culture and is therefore a convention.

Similar statements were also made about other studied services: a user (Craige) of w_PSS reported that other people consider laundromat users as poor; in the hometown of a non-user (Catherine), there is a stigma of not owning a bike associated to using the bike sharing system (b_PSS).

However, services, which involve shared goods, do not necessarily all have the same fate.

For example, non-users (David, Sarah) of the service example w_MS rather raised concerns that it could be exclusive (concept), if there is an expectation to buy (sign), or due to its hip interior (sign).

Also, in the last example, sign and concept were related through convention since one can argue about its exclusiveness. The examples illustrated that meaning statements, whose signs and concepts were related

through causality, were more often congruent with intended meanings and meaning statements basing the S-C relation on convention were more often conflictingly incongruent.

As the analyses of entities revealed, only the entity 'concept' of reconstructed meanings, but not the sign nor sign and concept together, was more often congruent than conflictingly incongruent with the concept of intended meanings, when the concept was related to a sign based on causality. It is assumed that the concept was of higher importance for the successful conveyance of intended meanings, due to its central role in making inferences.

Whether intended meanings were successfully reconstructed or not in meaning statements, whose signs and concepts were related through causality, was only reflected in the concepts of reconstructed meanings. It is therefore assumed, that two factors significantly determined the successful conveyance of intended meanings: first, as shown before, the relation of their signs and concepts based on causality, and second, their concepts, being easily taken up in reconstructed meanings.

It is recommended for design to be aware of conventions which can be applied in making inferences about their services. Additionally, designers could pay particular attention to concepts of reconstructed meanings, which come up during the simulation phase.

5.2.8 Further patterns in the conveyance of intended meanings

Figure 8 lists all intended meanings (M1-M14) per service example, and the reconstructed meanings which address them. The level of congruence between intended and reconstructed meanings is specified by the congruent of conflictingly incongruent entities. This figure allowed the researcher to identify further patterns in the conveyance of intended meanings. The following patterns were identified: mostly successfully conveyed intended meanings, if reconstructed meanings were only congruent to a full, high, or medium level; mostly unsuccessfully conveyed intended meanings, if reconstructed meanings only showed low congruence or were conflictingly incongruent with intended meanings; controversial intended meanings if levels of congruence on both ends of the scale were observed; rarely addressed intended meanings; and other abnormalities, such as high number of reconstructed meanings with congruent signs.

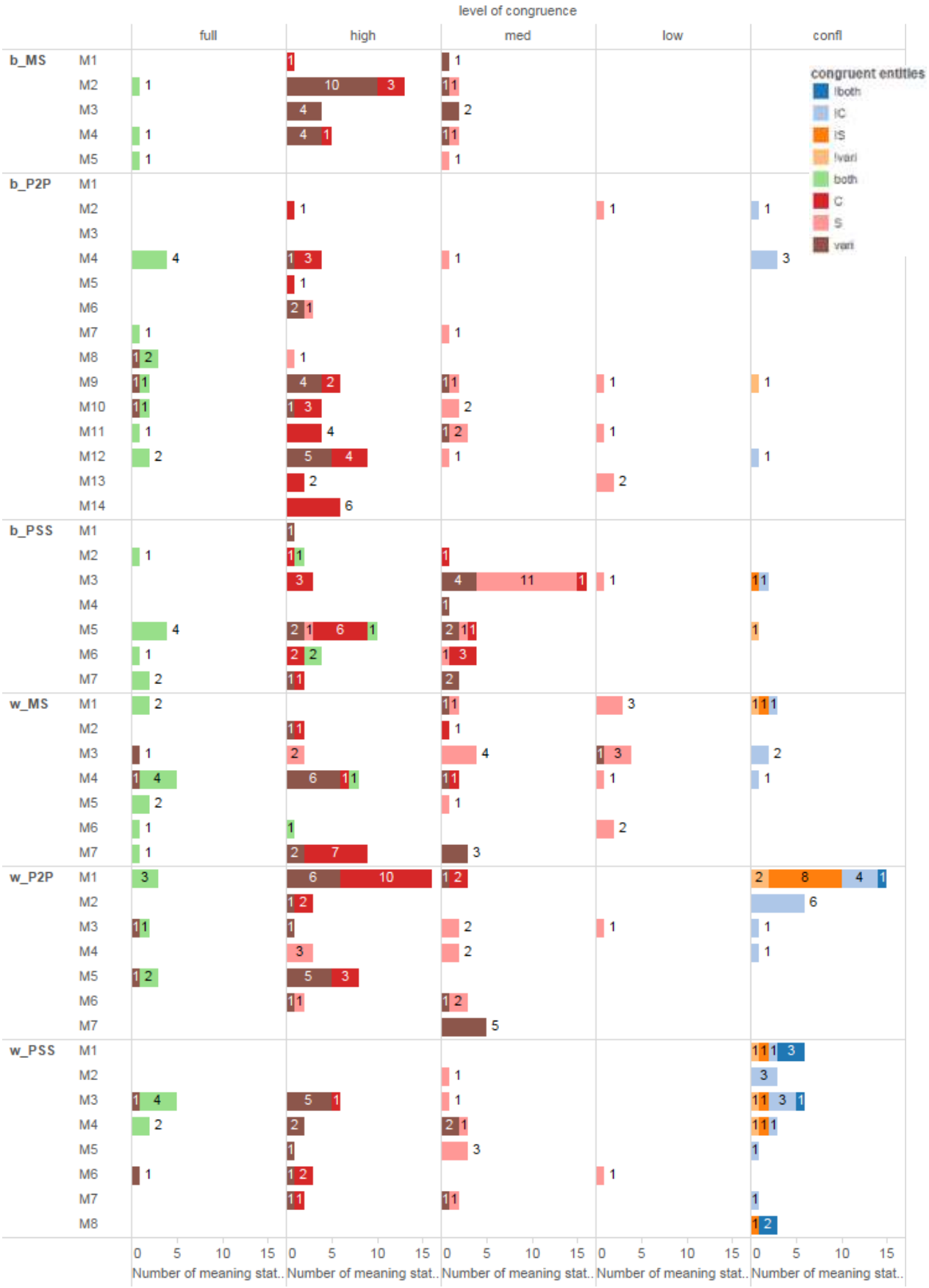

Figure 8: Congruent and incongruent (coded by '!') entities (color) per intended meanings and level of congruence

5.2.8.1 Mostly successfully conveyed intended meanings

The following intended meaning (**M2**) about the service **b_MS** was successfully reconstructed by all 17 meaning statements, which addressed an idea behind the intended meaning. For comparison, the other intended meanings about the service were only addressed five times on average.

The designers had in mind with running a café and combining it with a bike rental and a workshop (sign) that people can come along (object) and make it a social activity (concept).

Four reconstructed meanings made use of the concept 'community', five of the concept 'a place to meet' and three referred to the concept 'social space'. Nine meaning statements started the inference through perceiving the café.

It is assumed that the intended meaning was numerously successfully conveyed, since the designers made use of common associations between the café and social aspects.

The designer of the service **w_MS** intended (**M4**) to

'combine the useful with the nice things' (concept) in the service (object) by serving coffee and cakes (sign), while the laundry is getting done.

This intended meaning was successfully reconstructed in 21 out of 24 (88%) meaning statements, which addressed an idea behind the intended meaning. It was also the intended meaning for this service, which was most often addressed, when interviewees were prompted to infer the designer's intention: eight times compared to two times for the remaining six intended meanings. Five of these meaning statements were fully congruent with the intended meaning by referring to both sign and concept of the intended meaning.

For example, a non-user (James) concluded that the service (object) is making a chore into something enjoyable (concept). Another non-user derived from this combination of services which allows users to meet friends (sign) that they (object) can organize their social lives around it (concept).

It is assumed that the conceptual blending of 'doing household chores' and 'enjoying goodies' was easily conveyed through this service example, since both can be easily combined from a procedural perspective. In contrast, in the service example b_MS, the perception of the conceptual blending of 'cycling' and 'socializing' focused on the latter, whereas 'cycling' rather served as a common topic than as a common activity, since it would require leaving the place. In case the designers of b_MS would like to blend these concepts stronger, they could for example offer coffee to go in their own branded cup holders, or even make it the place a 'ride-thru' café or offer a whole experience of having a picnic in the countryside including a basket for bikes, a blanket, food and a free rental bike.

The following intended meaning (**M5 of b_PSS**) is also a good example for describing what makes an intended meaning being often successfully conveyed:

the designer tried to evoke about the service that 'it (object) is a speedy and flexible mode to get around in the city (concept)', since it is on demand (sign).

The intended meaning was successfully reconstructed 24 times, of which 63% were fully or highly congruent. This was the highest rate of all intended meanings of b_PSS. Only one single time, the meaning was conflictingly reconstructed. Moreover, only in 38% of the successful reconstructions, interviewees were prompted to infer the designer's intention, which is below the average of 58%.

As the high number of successful reconstruction indicates, the concept might not be far to seek for many users and non-users. Indeed, one part of the concept (getting around) is close the service's main purpose of providing mobility. Additionally, interviewees also derived similar concepts such as 'a way to see the city' and

'riding around'. Besides, the sign of the intended meaning was often perceived similarly and combined with the same concept of the intended meaning.

> *For example, one user (Paul) reported that he only realized after he had tried out the service how quick it was. He concluded that he 'can just grab and go immediately', since he does not need to wait for a bus or metro.*

This reconstructed meaning by Paul covered all parts of the concept, i.e. the speed and flexibility of a mode for getting around, and the sign of the intended meaning.

Sign and concept of the intended meaning were related through causality, which, as analyzed before, was a condition for facilitating the successful reconstruction of the meaning.

> In 20 out of 24 meanings, which successfully reconstructed the intention, the S-C relation was also based on causality.

It is assumed the concept of the intended meaning facilitated that a sign can be causally related to it.

5.2.8.2 Mostly unsuccessfully conveyed intended meanings

The designer of **w_MS** tried to convey (**M1**) the concept of 'relaxing':

> *Users (object) can relax (concept), since the service creates a good atmosphere through its calm machines, and a smell of coffee and fresh clothes (signs).*
>
> The intended meaning was not successfully reconstructed by 60% (6 out of 10) of the meaning statements, which addressed an idea behind the intended meaning.
>
> *One non-user (Ronny) took up the concept of 'relaxing' and used it as a sign: she would not be bothered about (concept) noisy washing machines (object), since during daytime she would not be in the mood for relaxing anyway. Another non-user (Sarah) would not be able to relax (concept) in such a multi-service laundromat (object), if there was a social pressure by other users to look tidy (sign).*

This example of intended meaning shows that a good intention by designers, i.e. allowing users to relax in good atmosphere, can also turn out to be interpreted contrarily: potential users might not be in the mood for relaxing, or rather prefer a casual environment of a normal laundromat.

The designer of **w_PSS** tried to convey (**M2**) that

> *the developed payment system for laundromats (object) is secure (concept), since it works with a large payment provider, which is also emphasized in the description of the service (signs).*
>
> However, three out of four reconstructed meanings, which addressed this intention, were in conflict with its concept.

The interviewees were rather concerned about the security or found it even risky to use online payment, since they perceived the money on one's user account as a target for a hack, or since they could be cheated.

Although people's way of thinking, resulting in opposed concepts, is assumable hard to be changed quickly, the designer could try to make use of more explicit signs, such as a certificate of safe online payment, or a two-factor authentication.

Another intended meaning (**M1**) about the service example **w_PSS** was:

> *The web app (object) is 'an obvious and intuitive way to pay and operate self-service laundry equipment (concept)', since it has clear and simple messaging (sign).*

This meaning was addressed seven times, out of which six were conflictingly incongruent. Interestingly, half of the conflicting meanings opposed both the intended meaning's sign and concept, which is the highest rate of all studied intended meanings with more than three conflicting meanings.

These three conflicting meanings were all made by non-users. They perceived the following additional steps in the 'customer journey', which were also indicated in the MeaningMap, compared to paying with coins: 'signing-up', 'loading money on account', and 'typing in service code'. These signs were opposed to the intended sign since the non-users inferred from them that the web app 'is too complicated' and 'requires to look even more into it'.

It seems that either the designer had misconceived the web app by neglecting signs, which can lead to opposed interpretations, or that the web app is only relevant to a small user group, who would successfully reconstruct the intended meaning. In any case, these conflicting meanings can inform a possible improvement of the web app. For example, the designer could reward users who sign up in order to make the investment of time seem smaller or streamline the use process by asking for a confirmation instead of the service code.

Also, a third intended meaning (**M8**) of the service example **w_PSS** received high opposition.

The designer did not regard the function of providing feedback to the users on the status of the washer (object) as a particular great value for users (concept), and in turn did not implement it, since peak times are very rare (sign), which implies that the chance is very low that users need to wait for a washer.

Three out of four reconstructed meaning statements were conflictingly incongruent with the intended meaning. Two of them had both, sign and concept in conflict with the intended meaning.

These statements were made by non-users (Gigi, Matthieu), who both concluded that it would be useful if the web app could tell the availability of the washers, since Gigi would be bothered if nothing was available (sign), and since Matthieu already experienced once a useless walk to a laundromat (sign).

Contrary to the intended meaning, the non-users did not bother whether peak times were rare or not, but rather how these times affect them. Therefore, these signs gave also rise to a concept, which is opposed to the intention.

It is assumed that the designer underestimated the effects of peak times on potential users, and therefore misconceived the value of the function of showing the availability of washers. These examples also showed that conflicting meaning statements do not necessarily have to have a negative valence.

One non-user (Sascha) agreed with the designer by concluding about the function of showing the availability (object) that it is probably not worth the trouble (concept), since one would be bothered when the last machine was taken right before someone. This happened to him during car sharing.

In order to prevent such use cases, the designer would additionally need to implement a reservation system for washers. A reservation system could also support interpretations such as 'having things under control' (concept), as it is already perceived by a non-user (Thore), since he could track costs in his smartphone in the payment history of the web app.

5.2.8.3 Controversial intended meanings

The intended meaning (**M4**) of the service **b_P2P** is an interesting example:

on the one hand, 44% of successfully reconstructed meanings were fully congruent with the intended meaning and address both its concept and its sign, which is the highest rate of all studied intended meanings with more than one fully congruent reconstructed meaning of all service examples. On the other hand, some reconstructed meanings were also conflicting with the intention.

The designer pointed out that:

> *'it (object) has a community aspect involved (concept)', since one can meet and talk to people, and help others through the platform (signs).*
>
> *For example, two users (Adrian, Megan) supported this conception by stating that 'it is a social kind of P2P service', since people are willing to help and maintain online profiles, and that 'it is creating personal experiences and relationships' through social interaction. On the contrary, another user (Clarissa) pointed out that 'it is not a community but a marketplace', since it has no means to identify with it, and it is hard to meet someone again, once they unlisted their bikes. Similarly, a user (Charlie) concluded that 'it is like a marketplace' since there is no offline community.*

As these meaning examples highlighted, the question whether the service is a community, a marketplace or both is very controversial. For sure, it partly depends on what users make out of the platform, and how they interact. However, it also depends on the service provider's involvement in community building, and support for users. For example, the designers could organize offline gatherings, or the designers could implement a forum on the online platform, which allows users to communicate for other purposes than renting.

One could be concerned that such a forum could make it possible for users to bypass the service charge of the platform. However, since the service also comes with an insurance, it can be assumed that users will stick to the intended rental system, in which the service provider handles the payments.

The designer of **w_P2P** intended (**M1**) to

> *'create relationships among people (concept)' through the service (object) since one can meet the neighbors for washing (sign).*
>
> 34% of the reconstructed meaning addressing this intended meaning are conflicting. The majority of these conflicting meanings opposed its sign by resenting that the neighbor would rather be a stranger.
>
> *For example, non-users perceived (entity: sign) the person offering the washer (e.g.: 'unknown person', 'obliged to talk'), the interaction with them (e.g.: 'washing at someone else's home'), or their home (e.g.: 'a stranger's flat') as negative.*

The high number of incongruent signs suggests that designers should improve the perceived aspects of the service and find more appropriate signs for addressing the communication discrepancy between the intended meaning and the non-users' reconstructed meanings. For example, by implementing trust-building mechanisms, such as reviews or proved identities, designers could achieve that the neighbor would not be perceived as stranger anymore.

One can argue that, as with all peer-to-peer services in the sharing economy, trust building is one of the main issue for this service example (Light and Miskelly, 2014). Since the service example has no rating system for users, which was also criticized by one interviewee, and no verification processes for users' identities, which are already standard for similar services, the negative reactions should not be surprising. Having these shortcomings in mind, the intention to 'create relationships among people' can be seen as wishful thinking.

The designer of the service **w_PSS** intended to convey

*through taking up and offering cashless payment through the web app (sign), that the service is both convenient (**M3**) and modern (**M4**).*

In addition, these intentions raised some controversy: 6 out of 20 reconstructed meanings of the intended meaning M3, and 3 out of 13 reconstructed meanings of the intended meaning M4 were conflicting.

For example, four non-users (David, Lisa, Thore, Tom) do not see any advantage, or no value in paying cashless through the web app, since it is required to go there anyway, and one can also pay cashless at the central payment unit in many laundromats. When being asked what the service conveys to young people, a non-user (Linda) concluded that it conveys that people (object) are superfluous (concept), since the service drives automation.

Designers would need to weigh these conflicting meaning statements against those, which successfully reconstructed the intended meanings in terms of their target user groups and in terms of competition. By enriching these statements with demographic data, designers and marketers could specify or refine its user groups.

The only user (Craige) of the service w_PSS, who was interviewed, was positively surprised (concept) since cashless payment is not common in laundromats (sign).

Therefore, it could serve as a differentiating factor in competition with other laundromats.

However, designers could even implement more functions through its web app in order to provide more value, also to those non-users, who did not find any advantage in the system so far. For example, additionally to a reservation system for washers, which was already mentioned before, the web app could make notifications for users possible, when a wash is about to finish, or a loyalty program.

5.2.8.4 Rarely addressed intended meanings

The designer of **b_P2P** intended (**M5**) to convey that

the service (object) is a lifestyle (concept), since people do not need to do sports, they choose it (sign).

This intention was only one time successfully reconstructed by a non-user (Dan), who mentioned that

the service, through providing access to bikes, supports users in building a lifestyle around cycling as transportation.

Apart from this service, the association to a lifestyle was also made for the service examples b_PSS and w_MS:

A non-user (Alex) stated that 'riding such a bike in the morning commute (object) would give you a new bohemian lifestyle (concept)', since the morning commute was a large part of your daily routines (sign). She added that it would be a healthy lifestyle on top of it. Klaus, a non-user of w_MS concluded that the service could make washing a lifestyle product, because of its coffee space, with its atmosphere and offerings.

The reconstructed meanings by Alex and Klaus, both drawing on the idea of a lifestyle, were not congruent with any intended meaning.

The examples about the concept 'lifestyle' highlight that it has the potential to be used by some people. Surprisingly, the concept was mentioned for all three sharing types. For the bike sharing service examples, the concept lifestyle was associated with cycling, whereas for the washer service example, it was associated with the enjoyment of a rather dull practice. These associations indicate the necessary enhancement of the service examples in order to be seen as part of a lifestyle. However, the meaning statements differ in whether these enhancements need to show an actual impact on one's daily routines (Alex, Dan) or if it suffices to deliberately choose the service over alternatives (designer of b_P2P and Klaus).

The designer of **b_P2P** intended (**M3**) that

> *the service could be a tool for bike shops to support the marketing and to become a hub for renters, since its website promotes bike shops online and directs renters to them.*
>
> In the empirical study, this intended meaning was not addressed a single time.

This is not surprising, since the intention was about the service's business strategy, which had not been implemented yet. Additionally, the intended meaning only indirectly concerned users, and therefore was not likely to be addressed.

From a design perspective, the intention highlights the interesting evolution of the service: initially, the service only aimed at private persons offering their bikes through the service's online platform. Soon the designers realized that they needed to open up to traditional bike rentals in order to broaden its range of offerings. However, as the designer reported in the interview, the bike rentals interpreted the service as a threat, and therefore shied away from collaborating with the P2P bike sharing service.

It is assumed that the strong national media coverage of the service's launch supported the interpretation by the bike rentals. In the end, the service's relations to potential partners were already pre-shaped during its launch.

The designer of the service **b_P2P** also intended (**M15**)

> *to ensure an excellent renter experience (concept) by checking every listing manually on plausibility and authenticity, and potentially demanding from the lister to refine it before making it public (signs).*
>
> These support processes were never addressed by any user or non-user during the interviews.

It is assumed that the mentioned signs were not visible to renters. In case it is important to the designer to communicate the company's efforts in quality control, they could for example visualize the processes on the website or publish statistics about it.

The designer of the service example **w_MS** intended (**M2**) to convey that

> *using the service (object) can be a calm but emotional experience (concept) since the interior in a retro style can bring back memories (sign).*
>
> The concept of an 'experience' was only addressed by two non-users (Leash, Klaus).
>
> *For example, Klaus ambivalently inferred from the service's emotional appeal (sign) that it is for people (object) who want to romanticize washing (concept), which might be appealing to many people, who want a life full of ups, but not to him. He based the concept of romanticizing, i.e. believing that something is better than it really is, on the assumption that users could also go to the café next door.*

Therefore, his meaning statement revolved at its core around the question, whether one should leave the laundromat in between, or stay. Designers could respond to his statement either by concluding that he is not among the target group or find and better communicate other ways than coffee to make him stay. For example, they could highlight free Wi-Fi for him as a sign, based on which he might review the concept of romanticizing.

5.2.8.5 Other abnormalities

The designer of the service **w_MS** intended (**M3**) to evoke

that users (object) can 'have a nice timeout from everyday life (concept)', since the service offers a nice atmosphere, and the service workers have a positive attitude and knowledge about customers (signs).

Only one non-user fully reconstructed this intended meaning by addressing both concept and signs, whereas the remaining six meaning statements, which also successfully reconstructed the intended meaning, only addressed its signs.

For example, one non-user (Matthieu) derived from seeing the interior (sign) that the laundromat is inviting people to stay. Another non-user (Dehia) concluded that it is the right place to take a coffee, after seeing that the laundromat is decorated like a real coffee shop. One user (Linda) reconstructed from the sign of trustful service workers that she can even leave during washing without needing to worry about her laundry, which is incongruent with the designer's intention of providing a timeout to users.

The interviewed designer realized that many people are rather busy and wanted to create an antipole in response. The designer also mentioned that many users might not even be aware of the many details, which make the service a place of well-being. However, since the concept 'timeout' was only addressed one single time, it is questionable, whether the designer tried to evoke it through the most suitable signs. For example, since some non-users inferred from free Wi-Fi that they could use the waiting time for working, it might be worthwhile for the designer to implement a dedicated time-out area, for example, with comfortable chairs for laying down, and headphones for tuning out.

One intended meaning (**M3**) about **b_PSS** stuck out and raised interest for further analysis:

42% (11 out of 26) of its successfully reconstructions only addressed its sign, whereas for all intended meanings it is on average only 15%.

It was also the intended meaning for this service, which was most often addressed, when interviewees were prompted to infer the designer's intention: 15 times compared to four times for the remaining six intended meanings.

It is assumed that intended meanings, which were most often addressed when interviewees were prompted to infer the designer's intention might indicate that their signs and concepts are easiest conveyed.

The designers expressed their intention (**M3**) in the following way:

'we are trying to get people bicycling more, by providing a reliable mode of transport at a low price (signs)'.

The reconstructed meanings, which only addressed the sign, showed a medium level of congruence, since they derived related meanings. In these meanings, it was acknowledged that the service is part of, or is fitting into a transit system, or is another option for transit.

For example, one user noticed the same color scheme as the other public transport options of the city.

Many interviewees concluded that it is used for modal share, that it increases the convenience of public transport, or that it leads to less cars and less crowded public transport modes. Therefore, in most cases (77%), the intended side effect of getting more people on bikes, was not addressed in reconstructed meanings, but other effects were reported.

Another interesting example is the intended meaning (**M7**) of **w_P2P**:

it was only addressed in five reconstructed meanings by a variation of its entities, which showed a medium level of congruence.

The designer intended 'to help (concept) people under 30 without a washer (object), when they live in tiny apartments and have no space for a washer (sign)'.

All reconstructed meanings agreed that it is for young people but used different signs for making the inferences such as being adventurous, technological-savvy, or resourceful. It is assumed that the interviewees were not aware of the circumstance that there are tiny apartments without space for a washer. However, the example also showed that designers could make this circumstance more explicit for generating more understanding.

5.3 The acceptance of services

The aim of this section is to analyze what determinants of reconstructed meanings and other factors influence the acceptance of services (RQ 2b). Drawing on Miceli and Castelfranchi (2001), acceptance is defined as a positive attitude towards the service. Therefore, the valence of meaning statements is the dependent variable in this analysis. Since only the extreme values of positive and negative valence provided clear conclusions about meaning statements, neutral and ambivalent statements were left out of analysis. The focus is on meaning statements, which did not successfully reconstruct an intended meaning. Thus, meaning statements, which successfully reconstructed intended meanings, were left out of the analysis, since they did not show negative valence, as all intended meanings were positive. It is shown in examples that even though designers did not intend to convey these negative meaning statements, they still can address these meanings by influencing the service's communicative potential. Therefore, in this section, determinants of these statements are highlighted and examples are discussed in order to finally derive recommendations for designers how these negative meaning statements can be addressed.

5.3.1 Thoughts by others

It is assumed that people express their dislike of a service in meaning statements with negative valence, which could in turn influence meanings made by others. Thus, these meaning statements could be barriers to the adoption of a service, which need to be overcome. Consequently, it is important to make services and users accepted by other users and non-users.

> Meaning statements, containing thoughts by others, showed more often a negative valence, than meaning statements involving interviewee's own thoughts. In turn, meaning statements with interviewee's own thoughts were more often positive than those statements containing thoughts by others ($p= 0.0016$; Fisher's exact test, two-tailed; $df=1$; $N=601$; Cramer's $V=0.15$). In many cases, the interviewees were prompted to infer what others might think, when they did not report it by themselves.

Possible explanations could be that interviewees think that others think more negative, or that interviewees refer to others for making negative statements.

> The valence of interviewee's own meaning statements was correlated with the valence of meaning statements containing thoughts by others, which the interviewee reported. Thus, interviewees showed more often meaning statements with positive valence through their own train of thoughts, when they only reported thoughts by others with positive valence throughout the interviews, than when they only reported thoughts by others with negative valence. Also, interviewees showed more often negative meaning statements through their own train of thoughts, when they only reported thoughts by others with negative valence, than when they only reported thoughts by others with

positive valence (p=0.01; chi²=6.6; df=1; N=182; Cramer's V=0.19). In this analysis, all meaning statements by users and non-users were included, also statements about service examples of which no designer was interviewed. Additionally, also meaning statements, in which intended meanings were successfully reconstructed, were included, since otherwise there would have been no interviewee reporting positive thoughts by others.

This correlation could indicate that reporting thoughts by others could influence one's own thoughts. Nevertheless, the correlation could also indicate that people are simply projecting their thoughts on others. Another explanation could be that interviewees looked for confirmations of their own thoughts in thoughts by others.

Further analyses were limited by the data set and its coding: for example, there was not enough data for analyzing whether the correlation between the valence of one's own meaning statements and the valence of meaning statements containing thoughts by others would also hold for statements about specific service examples. Additionally, since the sequence of statements was not coded, it was not possible to analyze whether statements containing thoughts by others were mentioned before or after one's own statements in order to reason about the direction of influence.

5.3.2 Self-referential meaning statements

When analyzing whether interviewees' self-referential or general meaning statements, were more often positive or negative, no correlation was found for meaning statements, **which did not successfully reconstruct an intended meaning** (p=0.32; chi²=1; df=1; N=169). In this analysis, all service examples were taken together.

However, when distinguishing whether these meaning statements, in which no intended meanings were successfully reconstructed, were **either made by users or non-users**, it turned out that a dependence of the valence of meaning statements on whether interviewees made self-referential or general meaning statements existed.

When meaning statements were made **by non-users**, their valence was significantly dependent on whether these non-users referred to themselves in the meaning statements or expressed the statements in general terms. Thus, self-referential meaning statements were more often negative and less often positive than general meaning statements (p=0.046; chi²=3.97; df=1; N=146; Cramer's V=0.16).

No correlation was found between the valence of meaning statements **by users**, and whether users expressed the statements in self-referential or general terms (p=1; Fisher's exact test, two-tailed; df=1; N=23). It has to be mentioned that the data set about meaning statements by users with negative valence was very limited.

For example, a non-user (Paul) of the service b_P2P anticipated that he (object) cannot be particular about the bike's condition (concept) when picking up the bike, due to the limited choice of bikes provided by their private listers (sign). He related this situation to himself by comparing it to the service example b_PSS, of which he is a user and has formed the habit to check the conditions of all available bikes at a station before choosing one of them. He further concluded about the service example b_P2P that it is almost a point of sale (concept), when choosing a bike (object) already online (sign).

The idea of making the online reservation of bikes 'almost a point of sale' might be intended by design in order to work towards closing the rental deal. However, this requires that the description of the bikes on the

online platform is very detailed, and that the owners of bikes keep them in good conditions in order to avoid any unpleasant surprises for the renters.

The two exemplary meaning statements by Paul highlight the importance of prior experiences for interpreting services. It is assumed about the direction of influence that non-users emphasize their dislike of a service by referring to themselves in meaning statements with negative valence, or that non-users, when relating a service to themselves, end up making more often meaning statements with negative valence than with positive valence.

When analyzing single service examples, the valence of meaning statements about either the service **w_P2P** or the service **b_PSS**, in which no intended meaning was successfully reconstructed, was significantly dependent on whether these statements were general or self-referential.

> Meaning statements about **the service example w_P2P**, in which interviewees referred to themselves, and no intended meanings were successfully reconstructed, were more often negative than general meaning statements (p=0.033; Fisher's exact test, two-tailed; df=1; N=45; Cramer's V=0.34). In turn, general meaning statements were more often positive.
>
> 82% (9 out of 11) of the negative self-referential meaning statements about the service w_P2P were in conflict with the intention (M1) to create relationships among people. These conflicting meanings have already been discussed in a previous section (Section 5.2.8.3: controversial intended meaning). One meaning statements did not address any intended meaning, and the remaining meaning statement was in conflict with another intended meaning (M2).
>
> *In this meaning statement, a non-user (Selina) concluded that the service would not be a continuous solution for her (object), since she would need to schedule an appointment every week (sign), which would restrict her flexibility (concept).*
>
> Interviewees made most often self-referential meaning statements with negative valence about the service example w_P2P: 11 statements compared to two statements on average about the remaining five service examples.
>
> From the perspective of the **MOSC-entities referring to the MeaningMap**, the dislike of the service w_P2P was mainly reflected in the entity 'object' referring to the map's layer 'people': 73% (8 out of 11) of these negative self-referential meaning statements concluded (indicated by the 'object') about 'people'. The remaining statements concluded about 'the service as a whole' or its 'processes'. Compared to the other five service examples, self-referential statements about the service w_P2P concluded significantly more often about 'people' with a negative than with a positive valence (p=0.0023; Fisher's exact test, two-tailed; df=1; N=18; Cramer's V=0.8).

It is assumed that interviewees might have felt the urge to distance themselves from this particular service example. Additionally, interviewees may make self-referential meaning statements with negative valence, which are reflected by the entity 'object' referring to the layer 'people' when they strongly dislike a service.

> Contrarily to w_P2P, self-referential meaning statements about **the service example b_PSS**, in which no intended meanings were successfully reconstructed, were significantly more often positive than general statements (p= 0.044; Freeman-Halton test, two-tailed; df=2; N=28; Cramer's V=0.48). In turn, general meaning statements were often negative or neutral and ambivalent. In order to emphasize the relation between self-referential meaning statements and their positive valence, the values of neutral and ambivalent meaning statements were included in this analysis.

From the perspective of the **MOSC-entities referring to the MeaningMap**, the acceptance of the service b_PSS was mainly reflected in the entity 'concept' referring to the MeaningMap's layer 'people': 83% (5 out of 6) of these positive self-referential meaning statements, in which no intended meaning was successfully reconstructed, based the move from premise to conclusion on ideas ('indicated by the 'concept') about 'people' involved in or affected by the service. The remaining statement referred for its concept to the layer 'processes'. Compared to the other five service examples, the concepts of self-referential meaning statements about the service b_PSS referred significantly more often to 'people' with a positive than with a negative valence (p=0.003; Fisher's exact test, two-tailed; df=1; N=21; Cramer's V=0.71).

For example, a user (Paul) concluded that he (object) enjoys riding (sign) to relief stress (concept referring layer 'people'). By that (sign), the service (object) became a big part of his recreation (concept referring to 'people').

It is assumed that depending on the service examples, positive and additionally self-referential meaning statements can emphasize the acceptance of a service. Since in case of the service example b_PSS, the designer's focus was on transportation and not recreation, these statements of acceptance highlighted that the user reinterpreted the service in a different way than actually intended in order to relate it to himself.

The service examples w_P2P and b_PSS explain, why no correlation was found when all service examples were taken together for the analysis: the two services are extreme cases, which are contrary to each other; one with significantly more often positive the other with significantly more often negative self-referential than general meaning statements. The remaining service examples were more balanced in terms of self-referential meaning statements with positive and negative valence.

These extreme cases highlight the importance of considering the valence of self-referential meaning statements by potential users during the simulation and evaluation phases of prototypical services: negative self-referential meaning statements can indicate strong dislike of a service, when potential users might feel urged to distance themselves from the service, and on the contrary, positive self-referential meaning can indicate that potential users have internalized the service by relating it to themselves.

5.3.3 Ways of inquiry by non-users

No correlation was found between the valence of meaning statements, which did not successfully reconstruct an intended meaning, and the ways of inquiry, through which non-users made these meaning statements (p=0.37; chi²=0.8; df=1; N=146). In this analysis, **all service examples were taken together**.

However, when analyzing **single service examples**, the valence of meaning statements about the service **w_P2P**, in which no intended meaning was successfully reconstructed, was significantly dependent on the ways of inquiry. Thus, meaning statements, which did not successfully reconstruct an intended meaning, were significantly more often negative, when these statements were made by non-users through (the way of inquiry) anticipating instead of observing aspects of the service example w_P2P (p=0.013; Fisher's exact test, two-tailed; df=1; N=44; Cramer's V=0.41). In turn, meaning statements, which were made through observations, were more often positive.

A closer look if the meaning statements of dislike, made through anticipation, addressed any intended meaning, revealed that 48% (13 out of 27) of these meaning statements addressed one specific intended meaning (M1: "it is creating relationships among people"), 37% (10 out of 27) did

not address an intended meaning, and the remaining 15% (4 out of 27) addressed other intended meanings. 77% (10 out of 13) meaning statements, which were in conflict with M1, were made by non-users through anticipating the customer journey of the service.

For example, three out of 10 incongruent meaning statements raised concerns about the safety of the service ('criminals may get access to victims', 'it could be that the washer does not actually exist', and 'there is a small risk involved to go to a stranger's house). Two other incongruent statements raised concerns about the cleanliness of the washers ('the hygiene of the washers could be compromised' and 'it involves the risk that clothes are not properly cleaned').

It is assumed that the customer journey and its implications on users were difficult to anticipate and therefore caused the high number of negative meaning statements. It could also be that both were also difficult to communicate for the designer but also in the study's material. Moreover, the service's reliance on people interacting in private settings, could explain why this service example was more often negatively interpreted than the service with the same sharing type P2P for bikes (30 compared to eight negative meaning statements).

From the perspective of the **MOSC-entities referring to the layers in the MeaningMap**, the correlation between valence of meaning statements and the ways of inquiry was only reflected in the entity 'concept' referring to the MeaningMap's layer 'processes'. Thus, meaning statements, in which no intended meaning was successfully reconstructed and whose 'concepts' referred to the layer 'processes' in the MeaningMap, were significantly more often negative, when these meaning statements were made by non-users through anticipation than observation (p= 0.029; Freeman-Halton test, two-tailed; df=2; N=34; Cramer's V=0.4). In turn, meaning statements made through observation were often positive or neutral and ambivalent. Due to data constraints, **all services were taken together** for this analysis. Additionally, in order to emphasize the relation, the values of neutral and ambivalent meaning statements were included in this analysis.

*In most of these meaning statements, interviewees anticipated using the service. For example, a non-user (David) of the service example **w_MS** inferred from the service worker, who is present at the laundromat (sign), that it is expected from users (concept) to eat and drink during the wait (object). The non-user disliked this expectation since one would need to spend more.*

However, as a user (Selina) clarified during the interview, users, who only wash, are not forced to buy food or drinks, but are even allowed to sit at the tables of the café. Since this convention was not visible, one would need to experience it. One non-user (Klaus) mentioned that people could even be seduced (concept) to spend more (object), when cakes or cookies are nicely presented.

It is assumed that designers do not necessarily need to relief this tension for (potential) users. The tension might keep some potential users away from the service but might also subliminally persuade others to spend more. Therefore, this design decision is about optimizing gains. Of course, designers could easily designate a 'consumption free area' to relief the tension for some people. Another strategy could be, as it was mentioned by a non-user (Volc) about the same sharing type for bikes (b_MS), that the service could be someone's 'third place' after first home, second work, where people could hang out. In turn, having more people in the place, which do not necessarily have to consume, could attract even more people.

Interestingly, **b_PSS** was the only service example, about which non-users made more meaning statements through observation than through anticipation. The same applied to all negative meaning statements about b_PSS: seven statements were made through observation, and one through anticipation. When comparing the service b_PSS to all other service example, it turned out that

significantly more meaning statements by non-users were made through observation about the service b_PSS than for the remaining five service examples. In turn, less meaning statements were made by non-users through anticipation (p=1.6 E-10; chi²=40.9; df=1; N=474; Cramer's V=0.29).

86% (6 out of 7) of the negative statements about b_PSS, made by non-users through observation, involved signs, which referred to the layer 'technical system' in the MeaningMap.

For example, a non-user (Alex) inferred from the technical system that 'the service (object) is taking up the sidewalk (concept)', and 'is ugly (concept) if all bikes look the same'.

The high visibility of the service example b_PSS can also have positive effects:

as one non-user (ee39) noticed 'the service sells itself through the distinctive bikes'.

It is assumed that this service example is very tangible and highly visible through the implementation of bikes, racks, and kiosks all over the public space in a city, which might also provoke some controversy. It is further assumed that on the same time aspects of the service are obvious enough that people less often need to rely on anticipation for making meaning statements about this service example than about the other services.

The service examples w_P2P, w_MS, and b_PSS, which were discussed in this section, illustrate, that it depends on the service, which way of inquiry, observation or anticipation, is dominant in non-users' meaning making. Whereas meaning statements made through anticipation often revolved around the customer journey and its implications on users, statements through observation often referred to the technical system of the service. For addressing dislikes, designers would need to figure out whether non-users rely more often on observation or anticipation for making their meaning statements about the service in order to decide, which way of inquiry they should turn their attention to.

5.3.4 Basis of relation between sign and concept of reconstructed meanings

When analyzing whether the valence of meaning statements was dependent on the basis of the relation between sign and concept, no correlation was found for **meaning statements, which did not successfully reconstruct an intended meaning** (p=0.069; chi²=3.3; df=1; N=161). In this analysis, all service examples were taken together. The third basis of relation called 'similarity' was left out of analysis due to limited data.

However, when analyzing **single service examples**, the valence of meaning statements about the service **w_PSS**, in which no intended meaning was successfully reconstructed, was significantly dependent on the basis of S-C relation. Thus, meaning statements, which did not successfully reconstruct an intended meaning, were significantly more often negative, when the sign and concept of each meaning statements was related through convention instead of through causality (p=0.049; Fisher's exact test, two-tailed; df=1; N=39; Cramer's V=0.33). In turn, meaning statements, whose signs and concepts were based on causality, were more often positive.

For example, two non-users (Lisa, Klaus) inferred independently from each other that the service w_PSS (object) would be too complicated for them (concept), since one would need to load money on one's online account first, and since one would need to enter a service code to start a washer (signs).

In both cases, one could argue about the level of complicacy of the use process, and therefore the S-C relation was based on convention. The following example in contrast to Lisa's statement highlights the conventional character of the previous S-C relations:

Another non-user (11) inferred that the service (object) is just for convenience (concept), rather than being complicated, since people always have their phone on them with credit loaded on it.

From the perspective of the **MOSC-entities referring to layers in the MeaningMap**, the correlation between valence and basis of S-C relation was only reflected in the entity '**concept'** referring to the layer '**people'**: thus, the valence of meaning statements, in which no intended meaning was successfully reconstructed, significantly depended on the basis of S-C relations in these meanings, when the meanings' MOSC-entity 'concept' referred to the layer 'people' in the MeaningMap (p= 0.032; chi²=4.6; df=1; N=84; Cramer's V=0.23).

More specifically, the correlation was also valid for concepts of meaning statements referring to the more detailed layer 'user' at level 3 of the layer involved (level 2) 'people' (level 1) (p=0.025; chi²=5.03; df=1; N=71; Cramer' V=0.27). In these analyses, all service examples were taken together, due to data constraints for analyzing a single service example. No correlation between valence and basis of S-C relation of meaning statements was found for any other entity referring to any other layer of the MeaningMap.

For example, when interviewees were asked what the service could tell about its users, two non-users (ee39 & Catherine) responded for different service examples (b_P2P & b_PSS) that a user probably cannot afford a bike and that there's possibly an associated a stigma of not owning the bike associated to the service, especially in deprived areas. For both interviewees the starting point of these inferences was a user, who is renting the bike (sign).

Whether renting can be related to the concepts 'not being able to afford bike' and 'stigma of not owning', both referring to the layer 'people', is a matter of discussion and therefore based on convention rather than causality.

In general, the correlations confirm the expectation that meaning statements, in which no intended meaning are successfully reconstructed, and whose signs and concepts are related through conventions, are more often negative, since conventions are more discussable than causalities. Nevertheless, these correlations were only valid under specific conditions: for a single service example (w_PSS); or for meaning statements whose concepts referred to 'people' in the MeaningMap.

The fact that w_PSS was the most controversial service examples, with the highest number of reconstructed meanings conflicting intended meanings, could explain why the correlation was only observed for this service example. Further, it is assumed that concepts, considered as the ideas, on which the moves from premises to conclusions are based, referring to the layer 'people' at level 1 of the MeaningMap, and more specifically, referring to 'user' at level 3 of the MeaningMap, reflected the subjectivity of disliking the services, such as through negative emotions or the absence of personal value.

The correlation between the valence of meaning statements and their bases of S-C relations should not conceal that there were also meaning statements with negative valence, whose S-C relations were based on causality, and meaning statements with positive valence, whose S-C relations were based on convention. Therefore, also these meaning statements could be an expression for disliking or liking a service.

However, sine negative meaning statements, which did not successfully reconstruct an intended meaning, were significantly more often related to convention as a basis of S-C relation than causality, designers could especially take care during simulation and evaluation phases, which signs, evoked by the service, can convey negative reconstructed but unintended meaning statements, whose S-C relations are based on convention.

5.3.5 Further factors influencing the acceptance of services

The aim of the following qualitative analysis is to carve out interesting meaning statements, which have not surfaced yet in the quantitative analysis, and from which improvements of the services' communicative potential can be derived. The focus was on **negative meaning statements, which were incongruent with intended meanings**, and therefore might contain factors influencing the acceptance of services, which had been neglected by designers. Additionally, only those meaning statements were analyzed, which were made by several interviewees, which indicates some social agreement. Statements about each service example are analyzed, except for b_MS since it did not evoke any negative meaning statements.

5.3.5.1 How a service is provided

> *Two non-users (Samantha, Catherine) concluded about a similar service (object) that it is imposed on people (concept), since it was initiated by the local council (sign). In other words, 'it was done for us not with us' (sign), and it (object) is possibly avoided (concept) in Catherine's hometown.*

Both meaning statements clearly criticized how the service was provided. It is assumed that if a service was of relevance for the public, it would be more often critically assessed than other service examples, since interests by diverse social groups need to be considered. Besides the two meaning statements above, this assumption is also supported by the previously mentioned meaning statement complaining that 'the service is taking up the sidewalk'.

The way how a service is provided might also be an underlying factor in the following meaning statement:

> *A user (Dan) reported that the service b_PSS might be a symbol of gentrification (concept) in the eyes of other people: i.e. the service (sign) stands for the renovation (concept) of deteriorated urban neighborhoods (object). He did not further explain why some people might find this meaning in the service, but in his point of view, this meaning was not fair, since there have been attempts to make bike share more accessible to low income people.*

It is assumed that some people might see the service example b_PSS, or also similar services in other cities, as symbol of gentrification, since they are primarily used by people with high income such as white-collar workers. Additionally, it is assumed that this meaning could have arisen when the service provider, acting in good intention to make the system with its bikes and stations more accessible for everyone (statement by the designer: 'really we want everyone to join'), expanded it from the city center to these critical neighborhoods without integrating the local community in the decisions on the expansion.

Based on these assumptions, the meaning statement by Dan illustrates, how good intention can have unintended consequences, only by the fact how the service was provided: a negative perception of the service can lead to people rejecting it.

A meaning statement by a user (Paul) of the service example can be interpreted as a support of the relation between the service and gentrification, regardless of whether the relation is actual or symbolic. In the statement, Paul explained that

> *the service makes the neighborhood (object) look good (concept), when people are paddling through its streets (sign).*

The subjectivity of the concept (looking good) underpinned how controversial the statement was. Since the service was called a symbol, it does not necessarily need to have an actual effect on gentrification. However, Paul's statement might indicate how a perceptual change of a neighborhood through newly set up bike share stations could also stimulate people with higher income move to deteriorated urban neighborhoods. In such cases, gentrification would be an unintended consequence by the designers of the bike share system.

In case designers want to find out and address potential dislikes by certain social groups in advance, they could involve critical social groups in the design and implementation of the service, or capture and analyze their opinions, such as it was done in this empirical study. Maybe it would turn out for this particular service example that it did not fit the daily routines of many people with low income, or that it did not resonate with their cultural background or that some people could not identify with or did not want to belong to the current social group of users, and therefore was rejected by them and in turn was mainly used by people with high income.

5.3.5.2 Preconceptions

Two meaning statements by non-users (Paul, Wiebke) highlighted potential quality issues of the service example.

> *Both concluded about the shared bikes (object) that they are certainly old and heavily used (concept), since they are offered through a P2P service (sign) or that their conditions are probably uncertain (concept) if they are not regularly maintained (sign).*

Whereas the first meaning statement expressed a general negative attitude towards P2P sharing, the second statement is more nuanced by its conditional reasoning. In turn, users would need to rely on recent reviews of bikes in order to gain confidence about the bikes' conditions before seeing them.

The first statement illustrated that the service is confronted by a negative preconception about P2P sharing. A look at the service's website would have revealed that there were also new bikes. The concern expressed in the second statement could be met by introducing a maintenance certificate, which could be approved by collaborating bike repair shops. However, it depends on the number of concerns raised, and the actual conditions of bikes, whether such certificates are worth the efforts in operations and control.

5.3.5.3 Concern for others

In two meaning statements, non-users expressed their concern for others when reasoning about the social implications of the service example w_PSS. The identification of these meaning statements was supported by the MeaningMap, which considered 'excluded people' as an own layer on level 3 of the layers 'affected' (level 2) 'people' (level 1):

> *The two non-users (David, Leash) stated that the service (object) does not suit older people (concept), since its electronic payment system requires of users to have a smartphone (sign, David) and to be tech-savvy (sign, Leash).*

However, there were also positive meaning statements, which involved the smartphone for making inferences. These meaning statements were easily identified, since they referred to the following layer in the MeaningMap: 'supportive' (level 3) 'physical resources by users' (level 2), which are part of the 'technical system' (level 1) of the service.

> *For example, a non-user (Thore) concluded, when thinking about his grandmother, that the service (object) could be interesting for older people (concept), if they see the smartphone as something new and exciting to discover through learning (sign).*

It is assumed that people could be influenced by such meaning statements about the appropriateness of the service for them. Designers could exert influence on a service's user groups, for example, by arranging introductory sessions into the electronic payment system after its launch which could be hosted by the service provider. By guiding older people in these sessions through the payment process and answering their questions, the service provider could prevent or mitigate that the service could be seen as excluding older people. Anyway, coins were still accepted in this service example.

5.3.5.4 Negative side effect

Three non-users (Gigi, 11, Anonymikus) disliked the service example w_P2P in their meaning statements by referring to a potential negative side effect: they anticipated that the service would be more time intense compared to alternatives, but all perceived different signs.

> *Gigi concluded that 'you (object) are going to spend more time (concept) doing laundry', since consumer washing machines are smaller than those of laundromats (sign). The non-user '11' inferred from listers of washers, who indicated on the website that they are open for chatting (sign), that the service is 'for people (object) who have time to spare (concept)'. Anonymikus mentioned that her peers could think that she (object) had too much time to spend (concept)', if she would use the service, which would require of her to schedule two appointments with the lister of the washer to drop and pick up the laundry (sign).*

These exemplary meaning statements by three non-users unveiled that doing laundry is a household chore for them, which should not take too much time. The designers of the service w_P2P recognized that their service could potentially be time-efficient, since, as expressed in one intended meaning (M5), users can find washers, which are close. The designers also intended (M1) to create relationships among people, which they supported by small icons on the website, through which people can indicate whether they are open for chatting, smoking, drinking coffee or not.

Certainly, relationships among people are preconditions for trusting interactions. However, it seemed that the designers have neglected to support both listers and renters of washers in the long run, so that they could sustain sharing the washers, since the platform does not contribute to time-efficient processes. For example, the designers could support making appointments by implementing a scheduling assistant, which integrates the calendars of both parties, or they could support the handover of the laundry by providing own branded laundry baskets with electronic locks.

5.3.5.5 Unintended consequence

Regarding the social implications of the service example w_MS, concerns were raised by non-users (David, Matthieu, Sarah) that the perceived expectation to buy, as it was already mentioned before, could shy away poor people from using the service.

> *For example, Matthieu concluded in his meaning statement that users (object) need to have a big budget (concept), when he took for granted that users need to eat and drink while washing each week (sign).*

Initially, the designers aimed at students as primary target group, since they are trendsetters. As it turned out, the service is mainly used by people with larger budgets. The designers explained that in the interview by the higher prices compared to un-attended laundromats. It is assumed that the perceived expectation to buy also contributed to the shift in the target group and can therefore be regarded as an unintended consequence.

However, this unintended consequence does not necessarily have to be a problem for the service example, if other user groups than students generate enough turnover. Additionally, since the service example is a private company, it does not have a public mission to serve everyone and to be inclusive, such as the service example b_PSS.

5.3.5.6 Trade-offs in design decisions

Another drawback of the service example was mentioned by a non-user (Thore),

> *who concluded about the opening hours (object) that they are very limiting (concept), when users want to make washing at this service a relaxed after-work activity (sign).*

Opening hours were also mentioned by non-users of the other two services for washing (w_P2P, w_PSS):

> *For example, a non-user (Ronny) concluded about the service w_P2P (object) that it allows users to wash outside the usual shop hours (concept), since they can wash in private homes (sign). Sarah inferred from a supermarket in her hometown, which has open 24/7 as the service example w_PSS, and which is highly frequented (sign) that long opening hours (object) are important to consumers (concept). Several other non-users of w_PSS (Chico, Selina, Sarah) started their inferences from the 24/7 opening hours (sign) when concluding that (Chico) 'the washing machines (object) are ready for anyone anytime (concept)', (Selina) 'you (object) can be spontaneous (concept) and wash when you want', and that (Sarah) 'the service (object) allows people to be more flexible (concept).*

These meaning statements indicate that long opening hours could be important to many people. It is assumed that the limited opening hours of the service w_P2P resulted from a trade-off made during the design decision of combining a laundromat with a café, which entails service workers, who in turn restrict opening hours.

However, it is assumed that the service example does not need to make trade-offs in terms of opening hours, since it could be transformed into a self-service laundromat at night by design. For example, the coffee area could be closed down and separated from the washing area by roller shutters. In order to inform the required cost benefit analysis, designers could prototype such a self-service mode at nights by installing a temporary barrier to the coffee area and gathering user feedback.

5.4 Service improvements from unintended factors in reconstructed meanings

This section is about meaning statements by users and non-users with positive or neutral valence, which did not successfully reconstruct intended meanings, since designers had not expressed the same or similar intended meanings in the interviews. Designers might not have considered these meanings, when forming their intentions. The aim of this section is to derive recommendations from these statements for designers, what they can improve about specific services' communicative potential for additional intended meanings (RQ 2c).

5.4.1 Implicit assumptions behind meanings

A user of the service w_MS (Linda) added a perspective on the role of the service workers in one of her meaning statements, which was not mentioned by the designer.

> *She concluded that she (object) 'can leave (in between) with a good feeling (concept)' and does not need to worry about her laundry, due to the presence of trustful service workers, who have an eye on her laundry (sign).*

The service workers were also addressed in intended meanings (M1 & M3):

> *'through their positive attitude and knowledge about customers (sign), service workers allow users (object) to have a timeout from everyday life (concept)' and 'get relaxed'.*

At first sight, the concept 'leaving in between' is opposed to the designer's intention to allow users to have a nice timeout, but only if it is based on the assumption that this can only be achieved in the service space. However, by additionally offering a drop-off laundry service, the company could also allow users to 'get relaxed' during busy days. Free, branded laundry bags could be a representation and constant reminder of the drop-off laundry service. Depending on the amount of service that users request, such as washing, drying,

ironing, and folding, the service provider could adapt the pricing. This extension of the service would leave the choice to the user, whether they wanted to 'get relaxed' inside or outside the service space. Then the service example would probably not be interpreted 'to be directed at people with much time', as it was mentioned by a non-user (Klaus).

5.4.2 Positive side effects

The concerns about one's own laundry, as mentioned in the previous section, was also of interest in connection to the service example w_P2P:

> *Two non-users (Lisa, David) concluded that clothes are safer at the neighbor and that it is less risky that clothes are stolen than at normal laundromats.*

Apparently, many people worry about the 'safety of their clothes' in laundromats. Surprisingly, these concerns were never addressed during the interviews with the designers. Both service examples, w_P2P and w_MS could build on these concerns, and make this positive side effect explicit, for example by emphasizing the personal touch.

Positive side effects were also mentioned in meaning statements about the service b_MS:

> *A non-user (Mike) concluded about the service b_MS that it (object) is promoting healthy living (concept) through hiring out bikes (sign). Another non-user (Natalie) inferred from hiring bikes (sign) that users (object) benefit from getting outside (concept).*

These health benefits, as positive side effects from renting bikes, were mentioned neither in the interview nor on the service's website. Cycling as a healthy practice might be obvious to the designers and to many (potential) users. However, by making the concept explicit, the designers could develop another way to 'encourage cycling', besides 'engaging with the whole community' (intended meaning M3). For example, the service provider could also rent store-branded fitness trackers or maintain its own workout groups on social-media-websites for cyclists. In turn, both signs, the fitness trackers and the workout groups, could give rise to the concept of cycling as healthy practice.

5.4.3 Unintended target group

> *A non-user (Dani) anticipated that 'you (object) would get one-on-one learning' (concept) about the bike through the P2P exchange (sign) when picking it up. She came to this conclusion, when thinking about her experience with the service example b_PSS, where she was left on her own.*

This meaning statement highlighted that the P2P-sharing of bikes could be interesting for beginners, a potential target group, which was not mentioned by the designer during the interview. The designer of the service b_P2P rather focused on travelers. Addressing beginners as potential renters could resonate with one motivation, brought up by a lister (Adrian), who is happy to be involved in a community by helping similar people. However, the question remains, whom he would consider as 'similar people': for example, through their shared practice, or through the same enthusiasm for or knowledge about bikes.

5.4.4 Powerful concepts

A user (Paul) made several interesting meaning statements, which did not successfully reconstruct intended meanings:

> *For example, Paul mentioned that the service (object) has an aspect of freedom (concept), which he likes, since he does not need to lock the bike, and can do one-way trips (signs). He also concluded that*

through this service, renting (object) is like buying at a vending machine (concept), since there is no need to talk to anybody (sign).

The concepts used in these meaning statements are very unusual, but powerful: freedom could potentially resonate with the aspirations of many people, the comparison to the vending machine could be easy to understand and memorable.

5.4.5 Service symbolizing users

A non-user (Klaus) anticipated that the service example w_PSS could convey about its users (object) that they are organized people (concept), when using their smartphones (sign referring to layer 'technical system' in the MeaningMap) for operating the washers and dryers at the laundromat.

In this meaning statement, the service and its 'technical system' symbolized the user as being organized. This perspective on users was not brought up during the interview with the designer of the service. It is assumed that the designer could build on such meanings by supporting users in getting even more organized in order to improve the overall image of the service. One idea could be to give away branded washing bags for regular customers, when they reached a jubilee, which they could presort their laundry at home.

In addition, the service example b_MS was used as a sign, standing for its users, in a meaning statement with neutral valence:

A non-user inferred from a person riding one of the hybrid rental bikes, which are one-of-a-kind (sign), that the person (object) is probably upscale (concept).

It is questionable, whether the designer of the service example intended to convey this meaning about its users through the service. Nevertheless, also such feedback could inform design decisions when refining the service. In case designers wanted to thwart the service's potential to evoke this meaning, they could for example work with social organizations (NGOs) and make this work more visible.

5.5 Differences between users and non-users

The aim of this section is to analyze differences in the determinants of reconstructed meanings by users and non-users and in other factors in order to relate them to their behavior (RQ 3). The dependent variable in this analysis is the distinction, whether the meaning statement was made by a user or non-user of the service. However, this distinction is not the best for analyzing the relation between meaning and behavior, since non-users, despite making similar meaning statements to users, might be precluded from using the service due to various reasons, such as the service only being available in a specific region. It was impossible to code the interview data with all these reasons. For example, not knowing a service could explain why someone had not used it so far, but the knowledge about a service could also contribute to elaborate explanatory statements why someone had rejected a service. In addition, the ownership of a washing machine does not necessarily keep people of from going to a laundromat. In fact, the designer of the service w_MS mentioned that 60% of the users have a washing machine at home and come for washing big items. Therefore, another aim of this analysis is to explore determinants of meanings, which can specify the distinction of 'dedicated' non-users and 'potential' users.

5.5.1 Valence

When analyzing the meaning statements by users and non-users by their valence, a correlation was found between those variables. Thus, meaning statements by users are more often positive and less

often negative compared to those by non-users (p=7.5E-07; chi²=24.5; df=1; N=474; Cramer's V=0.23).

When neutral and ambivalent meaning statements were included as a third value of valence, the correlation was also significant (p=2.2E-07; chi²=30.6; df=2; N=561; Cramer's V=0.23). However, the extreme values of positive and negative valence are more interesting, since they provided clear conclusions about the correlations. In these analyses, **all service examples were taken together**.

When analyzing the **three single service examples** with best data for comparing users and non-users, the correlation between valence of meaning statements, and whether these statements were made by users or non-users was **only** found for the **service example b_PSS** (p=0.0002; Fisher's exact test, two-tailed; df=1; N=89; Cramer's V=0.44). No differentiation was made, whether in these meaning statements intended meanings were successfully reconstructed or not. For the service example b_P2P, the values of the statistical test were: p=0.68; Fisher's exact test, two-tailed; df=1; N=75. For the service example w_MS, the values of the statistical test were: p=0.06; Fisher's exact test, two-tailed; df=1; N=86. It has to be mentioned that the data set was very limited for the analysis of the three service examples. Especially, there were only zero to two occurrences of negative meaning statements about the service examples by users.

Since meaning statements with negative valance could not successfully reconstruct intended meanings by definition, only meaning statements were analyzed, **in which no intended meaning was successfully reconstructed**. As it turned out, users made more often positive meaning statements about the service **b_PSS**, in which no intended meaning was successfully reconstructed than non-users (p=0.0005; Fisher's exact test, two-tailed; df=1; N=24; Cramer's V=0.74).

When analyzing the correlation between the valence of meaning statements and whether they were made by users or non-users from the perspective of **MOSC-entities referring to the layers of the MeaningMap**, the following specifics were found:

No matter whether all meaning statements about all service examples, only meaning statements, in which no intended meaning were reconstructed, or only meaning statements about the service b_PSS were considered, the correlation between the valence of meaning statements and whether they were made by users or non-users specifically applied to meaning statements whose MOSC-entity **'object' referred to the layer 'service as a whole'**, and whose entity **'concept' referring to 'people'** in the MeaningMap.

- For all meaning statements:
  - Object referring to 'service as a whole': (p=0.002; chi²=9.9; df=1; N=229; Cramer's V=0.21).
  - Concept referring to 'people': (p=6E-06; chi²=20.5; df=1; N=231; Cramer's V=0.3).
- For meaning statements, in which no intended meaning was successfully reconstructed:
  - Object referring to 'service as a whole': (p=0.035; Fisher's exact test, two-tailed; df=1; N=73; Cramer's V=0.26).
  - Concept referring to 'people': (p=4.1E-05; chi²=16.8; df=1; N=86; Cramer's V=0.44)
- For all meaning statements about the service b_PSS:
  - Object referring to 'service as a whole': (p=0.006; Fisher's exact test, two-tailed; df=1; N=42; Cramer's V=0.48).
  - Concept referring to 'people': (p=0.0003; Fisher's exact test, two-tailed; df=1; N=47; Cramer's V=0.59).

These results of the statistical tests indicate that users concluded more often about the service ('object' referring to the layer 'service as a whole') in a positive way than non-users and referred more often to 'people' in their ideas for moving from premises to conclusions (entity 'concept').

> Specifically, for the service **b_PSS**, the correlation between meaning statements made by users or non-users and their valence also applied to all meaning statements whose MOSC-entity **'sign' referred to the layer 'technical system'** in the MeaningMap (p=0.013; Fisher's exact test, two-tailed; df=1; N=18; Cramer's V=0.63).
>
> *For example, a user (Volc) concluded about the service b_PSS that it (object: service as a whole) 'makes people more social (concept)', since they can interact more during cycling than during driving their cars (sign). Another user (Dan) mentioned that he (object) can depend on (concept) the service, since there is always a bike available (sign), which makes the service very important to him. In both examples, the concepts referred to the layer 'people'.*

The exemplary meaning statements illustrate that the positive valence of meaning statements by users can stem from personal gains (being able to depend on it) or collective gains (more social people).

> *In contrast, a non-user (Catherine) reported that in her hometown, there is stigma (concept) for users (object) of not owning the bike associated to the service with its distinctively branded bikes (sign referring to 'technical system'). Since there was no follow up question, it can only be speculated whether this stigma kept her of from using the service in her hometown, which is similar to b_PSS.*

Her statement exemplifies in which context the technical system of the service can be negatively perceived (sign): as in the statements before, also this statement's concept refers to the layer 'people' in the MeaningMap, since the stigma is rooted in the collective consciousness of the general public.

In this section on the valence of meaning statements, it has been shown that users not only found more often positive meanings in the studied services, but also reconstructed more often positive meanings than non-users, which had not been intended by designers. It is assumed that users were more often sympathetic to the services.

No conclusion can be made whether these differences can explain their behavior of adopting or rejecting the service, since only the occurrences of positive and negative valence in meaning statements by users and non-users have been analyzed, and not the direction of influence. Therefore, it could be that meaning statements by users were more often positive than those by non-users because these statements were made by users, for example in order to retain consistency between one's thoughts and behavior. It could also be that persons became users because they found positive meanings in the services. Both directions of influence might even reinforce themselves. This circularity of influence between meaning and behavior is also reflected in the Meaning-Behavior Model (Chapter 3).

Additionally, specific layers of the MeaningMap had been identified, to which entities of positive meaning statements by users referred more often than statements by non-users. These references of MOSC-entities to the specific layers highlight which aspects of services were significantly more often addressed in the reconstruction of positive meanings by users. Especially the entity 'concept' referring to 'people' is interesting, since it also specified other correlations such as between the successful reconstruction of intended meanings of the service b_PSS and the basis of S-C relation.

It is assumed that these references of MOSC-entities to layers of the MeaningMap could be critically considered during the synthesis and simulation phases in design in order to anticipate whether the intended meanings can inform the relation between the valence of reconstructed meanings and the use of the service.

However, since these references to the layers of the MeaningMap only informed the valence of meaning statements, but the valence did not inform the successful conveyance of intended meanings, other ways need to be explored how designers could influence user behavior through successfully conveying intended meanings.

5.5.2 Self-referential meaning statements

Next, it was analyzed, whether users or non-users made more often self-referential or general meaning statements.

As it turned out, users made significantly more often self-referential meaning statements than non-users, who in turn made more often general meaning statements (p=8.4E-05, chi²=15.5, df=1; N=561; Cramer' V=0.17).

It was additionally analyzed, whether the correlation between meaning statements by users and the users' references to themselves was also valid for **meaning statements, in which intended meanings were successfully reconstructed**. As a result, when users successfully reconstructed intended meanings, they made more often self-referential meaning statements compared to non-users, who successfully reconstructed intended meanings (p=0.00096, chi²=10.9, df=1; N=344; Cramer' V=0.18).

The correlation between use and self-referential meaning statements was also true when **neither users nor non-users successfully reconstructed intended meanings** (p=0.003; Fisher's exact test, two-tailed; df=1; N=217; Cramer's V=0.22).

However, when further distinguishing these meaning statements, in which **no intended meanings were successfully reconstructed**, by their **valence**, it turned out that users referred more often to themselves (self-referential meaning statements) than non-users **only when making positive meaning** statements, and not when making negative meaning statements. It has to be mentioned that the data set about meaning statements by users with negative valence was very limited.

- The values of the statistical tests for **positive** meaning statements were: p=0.0057, Fisher's exact test, two-tailed; df=1; N=85; Cramer' V=0.33.
- The values of the statistical tests for **negative** meaning statements were: p=0.56; Fisher's exact test, two-tailed; df=1; N=84.

It is not surprising that only in positive meaning statements, in which no intended meanings were successfully reconstructed, users referred more often to themselves than non-users, since the same correlation was found for meaning statements, in which intended meanings were successfully reconstructed, which were only positive or neutral.

It can be concluded that users not only made more often positive than negative meaning statements than non-users, but also referred only in positive meaning statements more often to themselves than non-users, regardless of whether intended meanings were successfully reconstructed or not. In turn, non-users expressed positive meaning statements more often in general terms than users.

When analyzing the three **service examples** (b_P2P; b_PSS; w_MS) with best data for comparing users and non-users, it turned out that the correlation between use and self-referential meaning statements, in which **intended meanings were successfully reconstructed**, **only applied to the service b_PSS** (p=0.027; Fisher's exact test, two-tailed; df=1; N=70; Cramer's V=0.27). Thus, users, who successfully reconstructed intended meanings, made more often self-referential and less often general meaning statements than non-users.

Interestingly, in 91% (10 out of 11) of these self-referential meaning statements by users about the service b_PSS the same intended meaning (M5) was successfully reconstructed: 'It (object) is a speedy and flexible mode to get around in the city (concept), since it is on-demand (sign)'.

For example, three users (Dan, Joe, Dani) related the service b_PSS to themselves by making self-referential meaning statements, which also successfully reconstructed the intended meaning (M5): Dan concluded that 'it (object) is a great way to get around (concept) for me', since he can do free trips under 30 min for a small annual fee (signs). Joe inferred from situations in which he (object) only wants to go one-way on a bike (sign) that 'it is nice to know that it is an option (concept)'. Dani concluded that the service (object) makes her life flexible (concept), since she can go one-way and does not have to worry about the bike (signs).

Additionally, the correlation between use and self-referential meaning statements about the service **b_PSS** applied to the case, when **no intended meanings were successfully reconstructed** (p=0.016; Fisher's exact test, two-tailed; df=1; N=28; Cramer's V=0.52).

Judging from the three exemplary meaning statements above, personal gains are one way through which users related the services to themselves in their meaning statements, which in turn could explain their behavior. The Meaning-Behavior Model (Chapter 3) described more ways how meaning and behavior can be related. These ways (meaning-behavior mechanisms) is discussed with data from the empirical study in the following section.

It is assumed that relating a service to oneself, expressed in positive self-referential meaning statements, is the result of an internalization of the service by an interviewee, which is independent form whether intended meanings were successfully reconstructed or not. From the perspective of internalization, only the service example b_PSS and especially one intended meaning (M5) resonated significantly more often with users than with non-users.

It is assumed that distinguishing self-referential meaning statements by their valence might be a more informative indicator for relating meaning to behavior than distinguishing meaning statements by users and non-users. For instance, it circumvents the problem related to the distinction between users and non-users that non-users might make similar meaning statements like users but might have been precluded from using the service. Thus, positive and negative self-referential meaning statements could especially support designers of original products and services since they cannot rely on existing users. Additionally, non-users making negative self-referential meaning statements could be seen as 'dedicated' non-users. However, the indicators are not sufficient for relating meanings to actual user behavior, since there are many other influencing factors such as price, competition, available information, which play a role in user behavior.

Based on the assumption in the previous paragraph, it was analyzed whether the **comparison of a service to its competitors or alternatives** in meaning statements by users and non-users had an effect on self-referential meaning statements and their valence. The MeaningMap supported this analysis, since the references of the MOSC-entities to the service's 'competitors or alternatives' were covered by one layer of the MeaningMap, as part of the non-influenceable (level 2) part of the context of the service (level 1). Half of the references to the layer of 'competitors or alternatives' were made by the entity 'situation' of meaning statements.

As it turned out, the service examples were significantly more often compared to their alternatives or competitors in self-referential meaning statements by users and non-users than in general meaning statements (p=0.031; chi^2=4.6; df=1; N=733; Cramer's V=0.08).

Specifically, **in these self-referential meaning statements** by users and non-users, comparisons were significantly more often made in meaning statements with positive valence than with negative valence (p=0.044; chi²=4.1; df=1; N=106; Cramer's V=0.2). No correlation was found between making comparisons to competitors or alternatives and the valence for general meaning statements (p=0.3; chi²=1.1; df=1; N=518).

Value is defined as "a judgement of the relative desirability, usefulness, or worth of something" (Chandler and Munday, 2011) and is determined by making comparisons because of its relativity. Therefore, it is assumed that comparing the services to their competitors or alternatives was especially suitable for determining their positive personal value to users and non-users, but not for their negative value, i.e. personally disliking the services. This implies for designers that they would need to consider these comparisons during the analysis and simulation phases in order to create value to users (see Section 6.1).

Due to data limitations, it was not possible to further analyze the valence of self-referential meaning statements for example in the MeaningMap or by the successful reconstruction of intended meanings.

5.5.3 The meaning-behavior mechanisms

As it was shown in the section about the acceptance of the services (Section 5.3) and in the previous section, **self-referential meaning statements** yielded interesting insights into strong dislikes of services in case of negative valence, and the internalization of services, in case of positive valence.

The focus on self-referential meaning statements reduced the size of the applicable data set for their analysis. However, this focus made it possible to look at **mechanisms of mutual influence of meaning and behavior** (**meaning-behavior mechanisms**), which specify the mutual effects between meaning and behavior. These mechanisms were derived from theory and described through the Meaning-Behavior Model (Chapter 3).

The meaning-behavior mechanisms can be used not only for specifying user's behavior of adopting a service but also for specifying non-user's behavior of rejecting a service. It is assumed that these behaviors can be distinguished by the valence of the meaning statements. Additionally, the mechanisms can be used to describe both directions of influence: meaning influencing behavior, and behavior influencing meaning. In the initial Meaning-Behavior Model, only the first case was discussed.

5.5.3.1 The most often applied mechanisms

The majority of self-referential meaning statements were specified by two different meaning-behavior mechanisms: 57% (36 out of 63) of these statements with positive valence were coded by the mechanism 'enhancing the self-concept'; 86% (18 out of 21) of these statements with negative valence were coded by the mechanism 'protecting the self-concept'.

In the initial Meaning-Behavior Model, the two mechanisms were considered as one since they stemmed from the same theory. However, since the mechanism 'protecting the self-concept' was also observed in positive meaning statements, it suggested itself to be a stand-alone mechanism.

> *For example, when all three users (Linda, Sabrina, Selina) of the service example w_MS were asked whether the service is important to them, two replied that they have no 'real' alternative at the moment and therefore the laundromat is somehow important to them (Linda, Sabrina), and the other user (Selina) cannot live without it at the moment.*

Since the alternatives would be for example to go to another laundromat further away (Sabrina) and to wash by hand (Selina), their behavior of using the service can be described by the meaning-behavior mechanism 'enhancing the self-concept'. Linda mentioned that an alternative for her would be to sit in the cold at

another laundromat. Therefore, her meaning statement can inform her behavior through the mechanism 'protecting the self-concept'. Since they had recently moved into town, they might only use the service until they have access to an alternative, which might enhance their self-concepts more, for example an own washer.

Interestingly, all three users compared the service to alternatives for determining its importance. This observation is in line with the correlation between the valence of self-referential meaning statements and the comparison of services to their alternatives, which was reported in the previous section.

5.5.3.2 The least often applied mechanisms

The mechanism 'relating to the past' was only applied to specify nine out of 93 self-referential meaning statements. Interestingly, the mechanism specified more meaning statements by non-users than meaning statements by users (eight to one).

For example, a non-user (David) of the service example w_PSS concluded that the only personal added value (concept), which he could find in the service (object), it to pay cashless, since he is already used to pay be debit card (signs). Another non-user (Sarah) of the service example w_MS inferred from comparing the service to her experience in normal laundromats that the nice interior, the possibilities to sit down and to have a coffee (signs) reduce the strenuousness (concept) of waiting and looking after her clothes (concept). This is supported by another non-user (Matthieu), who inferred from seeing tables at the service example w_MS, that you have the possibility to stay.

Both examples show how already small things could potentially have an influence on choice behavior, i.e. choosing this service example over others.

It is assumed that non-users rely more often on their past experiences in order to make self-referential meaning statements than users, which can either express their dislike of the service or indicate its internalization.

The meaning-behavior mechanisms, which were least often used for specifying self-referential meaning statements, were the mechanisms 'forming an adaptive attitude' (applied in five out of 93 cases) and 'motivational quality' (only three times applied). The mechanism 'forming an adaptive attitude' was only applied to meaning statements by users.

It is assumed that an adaptive attitude can only be formed after considering new information, which was in this study only reported by users. An exemplary meaning statement, which assumable influenced behavior through its 'motivational quality' was given by a user (Adrian) of the service example b_P2P:

He mentioned that the service (object) is important to him (concept) since it allows him to explore other cities through his favorite mode of transport.

The meaning found in this service example, i.e. allowing him to explore other cities, was considered to be related to the behavior for the sole reward of being engaged in it.

It is assumed that the differences in how often the meaning-behavior mechanisms were applied, do not imply that one is more relevant to design than another one, neither that one is more likely to specify user behavior than another one. The differences may come from the fact that one mechanism can be applied more easily than another one. For example, the mechanism 'motivational quality' has narrow criteria for its application derived from its underlying theories (see Section 3.2.1). Comparably, the mechanism 'enhancing the self-concept' is rather broad, since the self-concept encompasses the "totality of the individual's thoughts and feelings having reference to himself as an object" (Sirgy, 1982). These examples also illustrate that the mechanisms are not mutually exclusive categories for relating meaning to behavior.

5.5.3.3 Mechanisms specifying negative self-referential meaning statements by users

In total, four negative self-referential meaning statements were observed, which were made by users. These negative meaning statements can be illustrated by the meaning-behavior mechanisms.

> *For example, one user (Clarissa) concluded about the service b_P2P that it (object) is not a community, but a marketplace (concept), after she had experienced that it was hard to meet people again once they unlisted their bikes (sign).*

It is assumed that she had formed an 'adaptive attitude' towards the service, since she kept on using it. 'Forming an adaptive attitude' is considered as one mechanism of mutual influence of meaning and behavior (cf. Chapter 3). Clarissa supported this adaptive attitude in another meaning statement, in which

> *she mentioned that the service (object) 'is a useful tool (concept1), since it is easy to rent through it (sign1), but I am not emotionally attached (concept2) to it', since there are also alternatives (sign2).*

In this ambivalent meaning statement, she made clear that she was still using the service, despite her negative experience, since it was easy to rent through.

> *Another user (Wiebke) inferred from her experience with riding a bike of a similar service to the example b_PSS (sign) in her hometown that 'you (object) are getting weird looks (concept).*

Since she resigned from using the service, her negative meaning statement could help her in justifying her resignation or could also be its cause. Anyway, her resignation and meaning statement influenced each other through the meaning-behavior mechanism of 'protecting the self-concept'.

5.5.3.4 Mechanisms specifying the mutual influence of meaning and behavior

The fact that behavior can also influence meaning, in addition to the other way around, was illustrated by one self-referential meaning statement:

> *a user (Paul) concluded about the service example b_PSS that 'it (object) became something that provides fun (concept) through cycling (sign). He admitted that he had not expected that.*

It is assumed that he formed an 'adaptive attitude' towards the service, since he initially signed up for a yearly membership of the service in order to just have an option.

The meaning-behavior mechanism of 'forming an adaptive attitude' might be worthwhile for designers to consider, when they are first trying to get 'a foot in the door', and then evoke intended meanings which need to be experienced.

The refined meaning of providing unexpectedly fun that the user found in the service can be interpreted as an indication that meaning can make behavior stick. This was also supported by another meaning statement by Paul:

> *he concluded that since he had good time with it (sign), the service (object) became a big part of his recreation (concept).*

5.5.3.5 Mechanisms specifying similarities between users and non-users

When comparing positive self-referential meaning statements by non-users and users, it turned out that many interviewees showed similarities in their meaning statements about several service examples. These similarities included the same meaning-behavior mechanisms and the successful reconstruction of the same intended meanings.

> *A user (Clarissa) of the service b_P2P inferred from using a bike rented through the service (sign) that she (object) would be labeled as a cyclist (concept) by others. Similarly, a non-user (Natalie) anticipated that she (object) can look cool (concept) on a hip bike rented through the service (sign).*

In both meaning statements, it was important to the interviewees to rent a special kind of bike through the P2P-sharing platform in order to 'protect their self-concepts' from the negativity of others. By that, they addressed and internalized one intended meaning (M9) by designers stating that through the service (sign) 'you (object) can find a variety of bikes worldwide (concept)'.

Similarities between users and non-users were also observed for the service example w_MS:

> *a user (Linda) concluded that the service (object) 'is more than (concept) only a place to wash' for her, since she goes there for having a coffee and reading the newspaper (signs). A non-user (Leash) concluded from her observations that one can have something to eat, drink, and listen to music (signs) that the service (object) would provide a better experience (concept) to her than the normal 'boring' laundromat, to which she used to go.*

Both self-referential meaning statements can be specified by the mechanism 'enhancing the self-concept' from the actual towards the ideal self. In case of the two meaning statements, the ideal self covered being more time-efficient and pleasurable. Both interviewees in these examples, user and non-user, successfully reconstructed the intended meaning (M4) by designers 'to combine the useful with the nice things (concept)' by serving coffee and cakes while the laundry is being done (signs).

Also, for the service example w_P2P, two meaning statements by a user and by a non-user were specified by the same meaning-behavior mechanism and addressed the same intended meaning.

> *A user (Clement), who is offering his washer through the P2P-sharing platform (sign), concluded about the service (object) that it is a way for him to meet new people (concept). Similarly, a non-user (David) expressed his preference (concept) for this service example (object) over the other two covered services (w_PSS, w_MS), since he enjoys to get to know people (sign).*

Both meaning statements can be specified by the mechanism 'relating to others', since the interviewees made reference to other users. This was also the intention by the designers (M1): they want to create relationships among people (concept) through the service (object), since one can meet the neighbors for washing (sign).

Finally, similarities were also found in self-referential meaning statements by users and non-users about the service example w_PSS:

> *a user (Craige) stated that he (object) used the service for drying a pile of clothes of his family (concept), since they were busy and could not dry them at home (signs). A non-user (Clement) concluded that if he had no washer at home, he (object) would prefer this service (concept) to the other two examples, since it is fastest and easiest to use (sign).*

The mechanism of 'enhancing the self-concept' can be used to describe the (potential) influence of these meaning statements on behavior: interviewees could enhance their actual self-concept through using this time-efficient service in order to be able to say about themselves that they tried to make the best of their available time. The designers of the service intended (M6) to reach busy families: the service allows busy families to do laundry (object) in a time-efficient way (concept), since it has machines with high load capacity, high spin speed, and short washing and drying cycles (signs).

The comparison between meaning statements by users and non-users showed that they can have similarities in the meaning-behavior mechanisms and at the same time in the addressed intended meanings. These similarities were found for four different service examples. The remaining two service examples either had a limited data set of self-referential meaning statements (b_MS) or no self-referential meaning statements by non-users at all (b_PSS).

It is assumed that these meaning statements by non-users can indicate their potential to become users, which can be for example valuable for estimating the further market potential of a product or service by collecting feedback by non-users. It is also assumed that this indication for potential use does not only apply to specific products and services, since the same patterns between users and non-users were found for all service examples with proper data.

Additionally, it is striking that in total five pairs of meaning statements by users, and by non-users about the same service were specified by the same meaning-behavior mechanism and successfully reconstructed the same intended meaning, whereas no such pair was observed for meaning statements in which no intended meanings were successfully reconstructed. Therefore, it is assumed that intended meanings can have an influence on non-users potentially becoming users.

5.5.3.6 Mechanisms specifying expectations by potential users

The non-user's (Natalie) potential for becoming a user of the service example b_P2P was already identified in the previous section. She addressed the intended meaning (M12) of the service (object) to provide global access (concept) by connecting people (sign)

> *when inferring from the service (sign) that she (object) has an option everywhere (concept) and can explore remote places. Another user (Clarissa) mentioned that one (object) cannot count on finding a bike (concept) in each city on her continent, since the service is not yet widely used enough (sign).*

Whereas the designer of the service aimed at providing global access to bikes, and a non-user related the service to herself based on the intention, a user made clear that the service does not provide global access. Clearly, the differences in these meaning statements revolve around the perceived coverage of the service. The examples illustrate that non-users can have expectations towards a service, which it cannot necessarily deliver. This can potentially lead to frustration, especially since the non-user already related the service to herself. In this case, the frustration could be that she could not 'enhance her self-concept'.

However, users can also tolerate some frustration in case expectations are not met by a service. For example, a user (Clarissa) of the service example b_P2P mentioned about a different aspect of the service that

> *'it (object) is rather as a marketplace than as a community (concept)', after experiencing that she could not meet people again after they have unlisted their bikes (sign). Nevertheless, she also made clear in another statement that she really likes the service b_P2P, because when renting a bike through its platform in another city, which would look like her own one (sign) she (object) would be labeled as a real cyclist and not as a tourist (concept).*

Both exemplary meaning statements were self-referential. The first one could have described her behavior though the mechanism 'relating to others'. The second meaning statement could describe her user behavior through the mechanism 'protecting the self-concept'.

It is assumed that in her case, to explain why she kept on using the service, the mechanism 'relating to others' was farther away from her self-concept and therefore less important for her than 'protecting the self-concept'. If the community aspect had been more important for her, she probably would have resigned from using the service. Therefore, her case is considered as an example for a pragmatic user. Additional research is needed in order to analyze whether the primacy of mechanisms with higher proximity to the self is a general rule.

5.5.3.7 Mechanisms specifying intrapersonally conflicting self-referential meaning statements

In two cases (David, Dehia), a single non-user made two self-referential meaning statements about the same service example, one with positive and one with negative valence, which were specified by different meaning-behavior mechanisms.

David concluded in one self-referential meaning statement with negative valence about the service example w_MS that

> *he (object) would shy away from washing there (concept) in order to avoid feeling bad (sign) if he did not additionally order something to eat or drink.*

This statement can be specified by the meaning-behavior mechanism 'protecting the self-concept' for informing his behavior of rejection. He explained that it would be expected to eat or drink something by the present service worker.

> *Contrarily, David also welcomed the presence of the service workers (object) in another self-referential meaning statement since they could help (concept) him to operate the machines for the first time (sign). He once made the experience at an unattended laundromat that he would have needed some assistance during operation.*

This meaning statement can be specified by the mechanism 'relating to the past'.

Dehia remembered the long wait for the laundry, when she used to go to a normal laundromat,

> *and concluded about the service example w_P2P (object) that the long waits could be avoided (concept) through the service, since she could go to another students' place, for example (sign).*

This meaning statement could inform her behavior through the mechanisms 'relating to the past' and 'relating to others'.

> *Contrarily, she later admitted that the service (object) is a bit scary (concept) since it involves to go to a stranger's house (sign). She remembered that she had always been told by her parents as a child not to talk to strangers.*

In turn, this meaning statement could explain her behavior of rejecting the service through the mechanism of 'protecting the self-concept'.

For both cases, it is assumed that the non-users, such as a user (Clarissa) in the previous section, experienced intrapersonal conflicts during the interview. It is uncertain whether they finally adopt the service or not, and therefore they could be considered as in-betweens. Assuming that designers had identified several conflicting meaning statements between various (non-)users, such intrapersonal conflicts could inform their decisions, which conflicts they could primarily try to resolve, since their resolution would more likely persuade non-users to adopt the service. Another basis of decision-making could be the number of non-users who made similar conflicting meaning statements.

5.5.3.8 Mechanisms from the perspective of the MeaningMap

Differences between the six meaning-behavior mechanisms were also reflected by the MOSC-entity 'concept' referring to specific layers of the MeaningMap.

> Concepts of self-referential meaning statements, which were specified by the mechanism 'enhancing the self-concept' referred most often to the layer 'processes' on level 1 of the MeaningMap, and more specifically to the layer 'customer journey' on level 2: 43% (18 out of 42) of the meaning statements specified by 'enhancing the self-concept', compared to 25% (14 out of 57) of the meaning statements specified by one of the other mechanisms.

Therefore, it is assumed that 'enhancing the self-concept' is most often achieved through using the service, observing, or anticipating its use.

> Regarding the mechanisms 'protecting the self-concept', relating to others' and 'relating to the past', 59% (17 out of 29), 46% (6 out of 13) and respectively 55% (6 out of 11) of the meaning statements' concepts referred to the layer 'people'. The data set for the remaining two mechanisms was too limited for making any conclusion.

Many interviewees expressed their feelings in meaning statements, which were specified by the mechanism 'protecting the self-concept':

> *for example, using the service w_P2P was interpreted as 'a bit scary' by a non-user (Dehia) and two other non-users (Gigi, Ronny) mentioned that they would not feel comfortable when going to a stranger's flat for doing laundry.*

'Protecting the self-concept' also specified a meaning statement through which a user (Paul) expressed his feelings in a positive way:

> *he concluded that he (object) enjoys riding the shared bikes of the service b_PSS (sign) in order to relief stress (concept).*

The concepts of meaning statements referring to the layer 'people', which were specified by the mechanism 'relating to others', covered in all six cases both a self-referential part in addition to a part relating to others.

> *For example, a user (Adrian) of the service example b_P2P concluded that he (object) can get to know a diversity of people (concept) through the opportunities for introduction and of interaction (sign) when renting a bike during his travels.*

In this example, the concept's part 'getting to know' is self-referential whereas the part 'a diversity of people' relates to others.

Similarly, the concepts of meaning statements referring to 'people', which were specified by the mechanism 'relating to the past', were also self-referential, whereas the relation to the past was often considered only in the context of the meaning statements.

It can be concluded that the MOSC-entity 'concept' of self-referential meaning statements, which were specified by the meaning-behavior mechanisms, oftentimes reflected the self-referential character of the statements, and that the mechanisms added important nuances to that: about the customer journey (enhancing the self-concept), about the interviewee's feelings (protecting the self-concept), the relation to others, and the relation to the past. Regardless of these nuances, designers could strive for 'concepts' which (potential) users can relate to themselves. This was already highlighted by many correlations which were only applicable for 'concepts' referring to people. However, when it comes to the details, designers could additionally consider these nuances of meaning-behavior mechanisms in order to decide on what they could focus on.

5.5.3.9 Mechanisms specifying thoughts by others

Due to a limited data set, it is not possible to test the relation between thoughts by others, expressed in meaning statements, and user behavior statistically. Some exemplary meaning statements illustrate what would be needed for analyzing the direct relation between the thoughts by others and one's behavior, instead of relating them indirectly through the valence of meaning statements. Additionally, these exemplary meaning statements were specified by meaning-behavior mechanisms.

During the interview, an interviewee (11) was prompted to infer what others might think, when they would see her using the service w_MS (sign):

> *She concluded in her response that they would possibly think that "you (object) don't have a lot of things to do (concept)".*

This is a good example for illustrating how anticipating thoughts by others can lead to hesitation in the adoption of services. The relation of the meaning statement to a potential behavior of rejection can be specified by the mechanism 'protecting the self-concept' from the perceived negativity of others. However, as the following examples illustrate, it is not always straightforward like that.

> *A non-user (Natalie) conceived of the service b_P2P that she (object) "can look cool" (concept) in trendy places (situation) on a hip bike (sign) rented through the service.*

For this self-referential meaning statement, the interviewee internalized the service by anticipating its use in a particular situation. It is obvious that she wants to be well received by others in order to 'protect her self-concept'. Even though the statement was made from her point of view, she was concerned what others might think. Such considerations were not coded in the current data set. Therefore, it would be required to additionally code whether the meaning statement contained a self-expression or not.

> *In a similar statement, a user (Wiebke) of b_PSS mentioned that "you (object) are getting weird looks (concept), if you ride such a bike" in her hometown, since it is rather the exception than the rule (signs).*

The statement is only valid in the context of her hometown, where such bikes are not common. It reflects that she wanted to 'protect her self-concept' from the perceived negativity by others. Actually, she had already resigned from using it at the time of the interview, which made her a former user. Since it was the only case, the interviews were not coded into such detail.

The three meaning statements highlight that a more detailed coding scheme, for example additionally covering former users and the self-expression to others, and a bigger data set would have been needed to analyze the relation between the impact of others on user behavior.

From the perspective of the meaning-behavior mechanisms, it is striking that all exemplary meaning statements, which included thoughts by others, were specified by the mechanism 'protecting the self-concept'. However, this observation cannot be generalized. For example, it is imaginable that users are influenced by the thoughts of others in a positive way and in turn, they relate themselves to others in their meaning statements.

5.5.4 Explicitly stating behavioral change and sustainability

The designers of the service examples b_PSS and b_MS **explicitly intended to foster behavioral change**:

> *they stated that they wanted to 'get people bicycling more' (b_PSS) and 'encourage cycling' (b_MS), but through different means (signs as perceptual cues). Whereas the designer of the service b_PSS intended to achieve this objective by providing a reliable mode of transit, the service b_MS pursued the objective by engaging with the whole community and cooperating with the local administration and businesses.*
>
> For each service example, four interviewees used the same or a similar concept in their reconstructed meanings as the intended meanings. Seven of them made the conclusion when being prompted to infer the intention of the provider, and half of them were users. However, no interviewee disliked the designers' intentions.

Therefore, it is assumed that the overt intention of fostering behavioral change does not necessarily encounter resistance, and 'dedicated' users might even advocate this intention. It is therefore possible to provide an indicative affirmation that users and non-users are aware of the designer's intention to persuade them and are fine with it. These questions were raised by Crilly (Crilly, 2011).

> Interestingly, all interviewees perceived different means (signs) than the designers for fostering behavioral change: users and non-users of the service example b_PSS mentioned that the service drives behavioral change, since it is integrated into a larger transportation system; people would see more other people cycling and would follow; it is cost effective alternative; it increases availability of bikes; it has easily recognizable stations everywhere; and it allows users short term rentals for getting a flavor about cycling. Behavioral change through the service b_MS happens according to its users and non-users since the service creates a place where enthusiasts can meet; creates a place to try out; and offers cycling courses (mentioned by two interviewees).

A meaning statement by a user (Paul) of the service b_PSS supports that the designer's intention to change behavior actually worked.

> *He concluded about the service that it (object) encouraged him to explore the city (concept), since he considered the stations of the bike share system on the map as destinations (sign), to where he could go.*

This particular meaning statement is also interesting, because the service example was considered as an actor in it, but actually, the user behavior of Paul was grounded on his interpretation of the station map.

Regarding the service example b_PSS, two interesting concepts for behavioral change were mentioned by several interviewees in general meaning statements, but not by its designer: three users (Adrian, Dan, Megan) referred to the first concept of a 'gateway drug', which describes that users of the service b_PSS can start cycling through it, experience its benefits, empathize with cyclists and keep on using it on a regular basis. The second concept was called 'normalization', which was mentioned by two users (Clarissa, Megan): the service normalizes cycling, i.e. it makes cycling seen more normal, when many people use the service and car drivers, for example, are getting used to it. Normalization could in turn motivate more people to start cycling and could be supported by the concept 'gateway drug'.

It is assumed that both concepts are welcomed by the designer of the service b_PSS, since it was mentioned during the interview that the company is trying to get people bicycling more.

With both concepts in mind, a look into self-referential meaning statements in the MeaningMap of the service example b_PSS revealed that a statement by a user (Paul), which referred to the layer 'using the service' as part of the 'customer journey' in the layer 'processes' on level 1 of the MeaningMap, can support the concept of the 'gateway drug':

> *initially thinking that he would only use it a couple of times, it (object) became a big part of his recreation (concept), since he had good time with it (sign).*

Another look into the MeaningMap revealed that another user (Dani) actually referred to the layer 'other users' on level 4, as part of the layers 'users' (level3) as 'involved' (layer 2) 'people' (layer 1).

> *She inferred from 'seeing similar people like her on the bikes' (sign) that she (object) feels connected to them (concept).*

It is assumed that her meaning statement can be the result of 'normalization', which can inform her behavior through the meaning-behavior mechanism 'relating to others'.

These examples illustrate how designers could harmonize different concepts for behavioral change during the development of a whole strategy for changing behavior. Seemingly, it was less important during the reconstruction of the designers' intention what means (signs) they apply to behavioral change. Designers could receive similar self-referential meaning statements, such as those by Paul and Dani during the evaluation phase, which could indicate that their intended strategy on behavioral change could actually work.

When analyzing **whether interviewees explicitly associated sustainability** with any of the services the following meaning statements were found:

Two designers addressed sustainability in one of their intended meanings:

> *The designer of the service example b_P2P mentioned (M6) that the service (object) allows users 'a more sustainable way of consuming (concept)' through sharing (sign).*
>
> Two out of 12 non-users and zero out of six users successfully reconstructed the intended meaning, whereas the median for the 13 other intended meanings was three non-users and one user.
>
> *The designer of the service b_PSS mentioned (M2) that the service tells about its users that 'they have a concern about the environment'.*
>
> This intended meaning was successfully reconstructed by respectively two out of seven non-users and out of 12 users. For comparison, the median for the six other intended meanings of the service example b_PSS was 2 non-users and 4.5 users.

It could be that the intended meanings were not easy to be reconstructed or simply not relevant to non-users and users since they were less often addressed and successfully reconstructed than the other intended meanings of the services.

From the perspective of the MOSC-entities referring to the layers in the MeaningMap, the following specifics of the associations with sustainability were found:

> for the service examples, which involve sharing bikes (b_P2P, b_PSS, b_MS), two different concepts were brought forward: first, being environmentally friendly, and second, reducing congestion and pollution. These concepts were only evoked by the sign 'cycling' and referred either to people or the city (object), e.g. making the city more environmentally friendly.
>
> Regarding the sharing type 'P2P' of both bikes and washers, the involved practices of sharing and reusing were perceived and linked to concepts, which covered various aspects of sustainability.
>
> *For example, a non-user (David) of the service w_P2P linked sharing to the environment by concluding that 'the service is about dissipating less'. Chico, another non-user emphasized the social aspect by concluding that coffee and sharing make doing laundry a bit more social. A non-user (Samantha) concluded about the service b_P2P that it is 'encouraging to be more economical' since it brings together people of the reusing culture.*
>
> In addition, six other non-users of the service w_P2P perceived the practice sharing, but linked it to other ideas than sustainability:
>
> *For example, one non-user (Anonymikus) mentioned that it is trendy to share. Dehia concluded that it is not surprising to see that, since people started to share everything.*
>
> Also, two out of three users of the service example w_MS associated sustainability with it:
>
> *Selina concluded that the service (object) is environmentally friendly (concept) since there are labels on the washers (sign), which say that they are good. The other user (Linda) mentioned that 'sustainability is important to the owners' since they are serving high quality and healthy food (signs).*

Interestingly, the users of the service w_MS perceived completely different signs than users and non-users of the other service examples. Regarding the service example w_PSS, no reconstructed meaning associated sustainability to it. It is assumed that sustainability is more difficult to communicate for the service examples w_MS and w_PSS than for the other service examples which involve the practices sharing through P2P platforms or cycling.

5.6 Summary

In this summarizing section, the results of the data analysis for each research question are compared in order to synthesize them into a whole picture of the successful transfer of meaning to foster behavioral change. Additionally, the generalizability, the reliability of the results and their connection to the Meaning-Behavior model are discussed.

5.6.1 Overview

A complete tabular overview of the results from the statistical test and factors from the qualitative analysis is provided in Appendices C and D. Here, only the main correlations and factors are presented. Their implications for design, especially from the perspective of the MOSC-entities and the MeaningMap, are discussed in Chapter 6.

5.6.1.1 Main correlations

In the following table (Table 13), the main correlations are summarized by the involved determinants of meaning. These determinants of meaning were either the target variable, the independent variable or a condition of a correlation. The table only mentions the relevant value of each variable for answering the research questions. For example, in order to answer research question 2b, the target variable 'valence of reconstructed meaning' was analyzed by independent variables. The relevant value of the target variable was the 'positive valence of reconstructed meaning' under the condition that no successful transfer of intended meaning was achieved. Some determinants of meaning were not applicable ('N.A.') to the analysis of the target variables. For example, the valence of reconstructed meaning did not inform the successful meaning transfer, since the valence determined whether intended meanings were successfully transferred. The code 'See RQ 3' used for RQ 2b indicates that the same correlation could apply to both research questions, however the question is about the direction of influence: are statements by users more often positive than those by non-users because they are users, or did they become users, because they found positive meaning?

Table 13: Overview of statistically tested determinants of meaning per research question (RQ).

determinants of meaning (variables)	*reconstructed meaning by users and non-users*		
	RQ 2a: determinants of meaning describing the successful conveyance of meaning (Section 5.2)	*RQ 2b: determinants of meaning influencing the acceptance of services (Section 5.3)*	*RQ 3: differences in determinants of meanings made by users and non-users (Section 5.5)*
successful transfer of intended meaning?	**yes**	no (for all correlations)	either yes or no
valence of reconstructed meaning	N.A.	**positive**	b_PSS: positive
self-referential meaning statement	Non-users of w_P2P: no	w_P2P: no b_PSS: yes	b_PSS: yes
statement made by	user	See RQ 3: valence	**user (-> desired behavior)**

determinants of meaning (variables)	*reconstructed meaning by users and non-users*		
	RQ 2a: determinants of meaning describing the successful conveyance of meaning (Section 5.2)	*RQ 2b: determinants of meaning influencing the acceptance of services (Section 5.3)*	*RQ 3: differences in determinants of meanings made by users and non-users (Section 5.5)*
basis of relation between sign and concept	b_PSS or w_P2P: causality	w_PSS: causality	either causality or convention
matched basis of relation between sign and concept of intended meaning?	causality: yes	N.A.	N.A.
valence of reported thoughts by others	N.A.	only positive	N.A.
ways of inquiry by non-users	x	w_P2P: observing	N.A.

Legend:
x: no correlation was found
N.A.: not applicable to analysis
b_, w_: shared good: bike, washer
P2P, PSS: sharing types: peer-to-peer, product-service system

Relevant value of...
- target variable
- independent variable
- variable as condition

5.6.1.2 Qualitative specifics

In addition to the statistical testing of determinants of meaning, a qualitative analysis revealed influencing factors for each research question and actor involved in the meaning transfer. They are summarized in Table 14.

Table 14: Overview of influencing factors for each research question (RQ) resulting from the qualitative analysis

influencing factors *per research question (RQ) and per actor*		*RQ 2a (Section 5.2.8)*				*RQ 2b (Section 5.3.5)*	*RQ 2c (Section 5.4)*	*RQ 3 (Section 5.5)*
		intended meaning being …				*reconstructed meanings …*		
		successfully conveyed	*unsuccessfully conveyed*	*contro-versial*	*rarely addressed*	*disliking the services*	*revealed potential improvements*	*specified by M-B mechanisms*
designer			downplayed use case misconception of service	wishful thinking		unintended consequence negative side effect trade-offs made	implicit assumption positive side effect	
service	evoked meanings': sign				not visible or suitable sign		symbolizing its users	
	concept	concept not far to seek					powerful concept	
	sign and concept	common association						
non-user and user			people's general perception	what users make out of service		relevance to general public	neglected target group	non-users: relate to past; users: form adaptive attitudes.

influencing factors *per research question (RQ) and per actor*	*RQ 2a (Section 5.2.8)*				*RQ 2b (Section 5.3.5)*	*RQ 2c (Section 5.4)*	*RQ 3 (Section 5.5)*
	intended meaning being …				*reconstructed meanings …*		
	successfully conveyed	*unsuccessfully conveyed*	*contro-versial*	*rarely addressed*	*disliking the services*	*revealed potential improvements*	*specified by M-B mechanisms*
		good intention interpreted contrarily	out-group		concern for others		Intra-personal conflicts

The influencing factors are named in rather broad categories. These broad categories should not hide the fact that the influencing factors were revealed by a research method, whose tools MOSC-entities and MeaningMap (see Section 4.3) can also be used in design methods (see Section 6.4). Thus, through this methodological transition, these influencing factors can be easily translated into design practice.

For example, the influencing factor 'unintended consequence' was revealed in a meaning statement reporting the dislike of the service example b_PSS by others, who perceived the service as a symbol for gentrification (Section 5.3.5.1). By analyzing the statement through the MOSC-entities, it became clear that the matter of interest (entity: object) for these people was their neighborhood. The service did not necessarily need to have an actual effect on their neighborhood. It sufficed that an effect is perceived. This difference was considered in the basis of relation between the MOSC-entities sign and concept: they are related through causality, i.e. having an actual effect, or convention, i.e. an effect is perceived effect. By contrasting the meaning statement with the good intentions by the designer, it turned out that this statement disliking the service actually brought up an unintended consequence. The unintended consequence could have been neglected or also underestimated. Once this unintended consequence is identified during simulation, it can be addressed by the same tools applied in design methods.

Influencing factors also concerned the service as an actor. It was considered as a non-human actor, since most of the time users and non-users only perceive a service's technical system, from which they reconstruct meanings, and since the service can potentially have its own intelligence. The service as a non-human actor was reflected during the interview: one user (Paul) concluded about the service example b_PSS that it encouraged him to explore the city.

For example, one influencing factor on the service's communicative potential is that it can symbolize its users. This factor could inform designer's decision on how to improve the communicative potential of the service. In addition, this influencing factor was revealed by analyzing a reconstructed meaning through the MOSC-entities and the MeaningMap (see Section 5.4.5): the service was considered as the entity 'sign' and the user as the entity 'object'.

An influencing factor of the service on the successful transfer of intended meanings was found by analyzing a mostly successfully conveyed intended meaning (M2) about the service example b_MS through the MOSC-entities: since the intended meanings sign and concept were exceedingly often successfully reconstructed, and the sign was inherent part of the service, it is assumed that the service was able to evoke a 'common association'.

The identified influencing factors of users and non-users on the research questions can be summarized by the theme 'the social construction of technology', referring to the sociological theory of the same name mainly developed by Pinch and Bijker (1984): various social groups, such as users, out-groups, and neglected target groups, shape technology as they are shaped by technology in return. The influence of the social

groups on technology was also reflected in reconstructed meaning statements. For example, by concluding in meaning statements for whom the service is meant for and for whom not, people co-determine the actual user groups. Another meaning statement about the community aspect of the service example b_P2P made clear that users, especially for P2P-sharing services, in their role of listers, actively contribute to how the service had evolved and will further evolve.

It is discussed in Section 6.1, how these influencing factors, resulting from the qualitative analysis of the meaning statements, can inform design efforts.

5.6.2 Answering and comparing the research questions

It is now possible to answer the four research questions (RQ 2a, 2b, 2c, 3) of this empirical study:

RQ 2a: What determinants of meaning do describe the successful conveyance of meaning through products and services as a communicative medium? The empirical study shows that users successfully reconstructed the intended meaning more often than non-users, which is not surprising since they have more experience with the services, especially through interfacing with them. Intended meanings are more often successfully reconstructed in general terms than through relating the service to oneself. Most importantly, intended meanings are more often successfully conveyed when their signs and concepts are related through causality than through convention.

RQ 2b: What determinants of meaning do influence the acceptance of products and services? In order to avoid overlapping with RQ 2a, only reconstructed meanings were analyzed, which were not congruent with an intended meaning. The empirical study shows that thoughts by others are correlated to positive meaning statements: when only positive thoughts by others were reported, users and non-users made more often positive than negative meaning statements compared to the situation when only negative thoughts by others were reported. The acceptance of services through positive meaning statements, in which the services were related to oneself, depended on specific service examples: a highly controversial service (w_P2P) was only accepted in statements in general terms, whereas another service (b_PSS) was accepted in self-referential meaning statements, which were not intended by designers. As before, reconstructed meanings were more often positive when their signs and concepts were related through causality than through convention.

RQ 2c: What are factors of reconstructed meanings, which have not been intended by designers, which can improve the communicative potential of services? This research question was only analyzed qualitatively. Instead of listing the identified factors, which are named in broad terms, the process of how they were identified should be emphasized: the tools applied in the research method allows designer to directly translate the identified factors to the design phase. Thus, for answering this research question, the how is more important than the what.

RQ 3: In what determinants do reconstructed meanings by users and non-users differ to explain eco-sufficient behavior? Meaning statements by users are more often self-referential and positive than those by non-users. However, it seems that for the studied service examples it was not relevant whether the scripted behavior of sharing was eco-sufficient or not since users related the services to themselves through other means.

A comparison of the relevant determinants of meaning, which informed the research questions 2a & 3, yielded the following insights into the relation between successfully conveyed intended meanings and user behavior:

- Despite the dependence of the successful transfer of intended meaning on causality, as the basis of relation between its sign and concept, meaning statements by users and non-users were indifferent

towards the basis of relation and also towards the successful transfer of intended meanings. It is assumed that designers were not able to directly influence behavior through successfully conveying meaning.

- This is supported by self-referential or general meaning statements: on the one hand, intended meanings were more often successfully reconstructed in general meaning statements, but on the other hand, self-referential meaning statements were more often made by users and non-users. It is assumed that it was exactly this self-reference in the meaning statement to relate a service to oneself, which potential users needed to contribute in their reconstructed meanings about a service to the designer's intended meanings in order to be distinct from non-users' meaning statements. It is further assumed that a self-referential meaning statement is the outcome of the internalization process, in which a service is related to oneself in a positive way.

In addition, the comparison between the research questions 2b & 3 yielded interesting insights into the relation between acceptance and user behavior:

- The correlation between the positive valence of meaning statements and users informed both research questions. It highlighted that no conclusion can be made about the direction of influence of these determinants of meaning.
- As discussed in research question 2b (Section 5.3), the valence of meaning statements reporting thoughts by others was correlated to the valence of one's own meaning statements. Since users significantly more often made positive meaning statements than non-users, it is assumed that thoughts by others are also related to the difference between meaning statements by users and non-users. However, the data set limited the analysis.
- Interestingly, self-referential meaning statements were related to the target variable of both research questions for the service example b_PSS. It highlighted the importance of the combination of self-referential meaning statements with positive valence, which was also decisive in explaining differences between users and non-users.

Comparing the determinants of meaning answering the research questions 2a & 2b yielded interesting insights into similarities between the successful transfer of meaning and the acceptance of services, although the latter only covered meaning statements in which no intended meanings were successfully reconstructed:

- Both target variables were dependent on the same basis of relation between signs and concepts of meaning statements. It highlighted the importance of causality as the basis of relation, which was not only used more often in reconstructed meaning statements with positive valence than convention, but also resulted more often in successfully conveyed intended meanings when both intended and reconstructed meaning's relation of sign and concept were based on causality and not convention.
- The service example w_P2P specified the correlation of the same determinant of meaning in both research questions: non-users more often successfully reconstructed the intended meanings in general meaning statements than in self-referential meaning statements; additionally, interviewees made more often meaning statements with positive valence in general terms than by relating the service to themselves in self-referential meaning statements.

5.6.3 Connecting the results to the Meaning-Behavior Model

Even though only the meaning-behavior mechanisms and no other parts of the Meaning-Behavior Model (see Chapter 3) were applied in the empirical study, it is possible to make further connections between the empirical study, its results, and the model. These connections are made by reflecting on the process of

meaning making by interviewees, on the arisen conflicting meaning statements, and on the feedback loops in the model based on reviewing and meaning maintenance.

Meaning making by users and non-users is considered as a two-step **process** in the theoretical model: first, appraising meaning and second, comparing the appraised to their global meaning, both through emotional and cognitive processing. Meaning making, according to Park (2010), aims at "searching for comprehensibility and for the significance" of an experience. It is assumed that many general meaning statements, in which interviewees did not refer to themselves, reflected the search for comprehensibility, which led to the higher number of general meaning statements successfully reconstructing intended meanings than self-referential meaning statements. However, for making some general meaning statements, interviewees might have searched for significance as well, but not for their personal significance. In turn, self-referential meaning statements are considered as a special case, in which interviewees found personal significance. They are a special case since a service could also be of significance to other people or other ends. Additionally, the valence of meaning statements analyzed in the empirical study reflects the emotional processing of meaning making.

According to the model, it may turn out from the comparison of appraised and global meaning that they stand in **conflict** to each other. In the model, this conflict was called 'discrepancy'. It is assumed that meaning statements with negative valence are expressions of such discrepancies, since interviewees' appraised meanings were in conflict with, for example, their beliefs, or the goal that they pursued, both part of their global meanings. It is further assumed that in such cases, interviewees did not maintain their meanings but accepted the discrepancy.

Due to their experience, it is assumed that users were able to make meanings by **reviewing** their "behavioral episodes" (DeGrandpre, 2000) with the studied services. Such reviews were observed in some meaning statements. For example, as reported in Section 5.5.3.4, the service b_PSS progressed in its significance for a user (Paul). Since the behavioral episode was affirmed by the self-referential meaning statements of the user, it is assumed based on the ideas of DeGrandpre (2000) that this affirmation can make the behavior stick.

Efforts in **meaning maintenance** were also observed in meaning statements. For example, after a user (Clarissa) of the service b_P2P had found out that the service is more like a marketplace than a community, she assembled new meanings, as one of five way of meaning maintenance (Proulx and Inzlicht, 2012), in which she admitted that the service is a useful tool anyway (Section 5.5.3.3) and mentioned that she would be seen as a real cyclist when renting a bike through the service abroad (Section 5.5.3.6).

5.6.4 Generalizability

It is assumed that the results, which applied to all covered service examples tend to be generalizable. However, as shown in Table 10, most correlations were only valid for specific service examples. For instance, causality as the basis of relation between sign and concept of meaning statements, only contributed to the successful reconstruction of intended meanings about the service example b_PSS and w_P2P. In many cases, the variables were already too specific for further distinguishing them by the service examples.

However, the correlation between successful reconstruction of intended meanings and the use of a service applied to all three service examples with best data for comparing users to non-users (Section 5.2.2). Therefore, it is assumed that this correlation would also apply to other services.

The service examples b_PSS and w_P2P are interesting since they were extreme cases regarding the valence of self-referential meaning statements: whereas self-referential meaning statements about the service

example b_PSS were more often positive, those about the service w_P2P were more often negative (Section 5.3.2). Even though these results are very specific and cannot be generalized, they are nevertheless very informative for designers, for example when testing the acceptance of services. Therefore, the missing generalizability of the results is not considered as a reason against deriving recommendations for designers from similar results.

5.6.5 Reflections and limitations

First, it is reflected on the ambivalence of meaning statements, on the basis of relation between sign and concept, on other thematic groups for coding the meaning statements, and on the measures of association of the statistical tests. Then the limitations of the empirical study are discussed.

Meaning statements were considered as **ambivalent** due to several reasons (see Section 4.3.4), which were not always conducive to answering the research questions:

> *For example, a non-user (Selina) of the service w_P2P replied to the question, what her friends might think, that they would see the service (object) as an extraordinary experience (concept), since it requires to go to a stranger (sign).*

In this example, the concept was ambivalent: extraordinariness could imply either something remarkable and involving something exciting or something unusual and rather be the exception than the rule. The interviewee was not probed in order to clarify the concept.

Due to their ambivalence, many meaning statement cannot lead to clear recommendations for design improvements. For example, the designers of w_P2P could either strengthen the experiential character of the service by gamifying its use (e.g. earning points for washing at many different people's places) or the designers could focus on the service applicability to unusual use cases, such as during travelling, by partnering with tour operators and tourist offices. Therefore, these ambivalent statements would need to be enhanced with additional information in order to get a clearer picture.

> *In another example, a non-user (Klaus) concluded about the service w_PSS that 'it (object) is trying to catch up with technology (concept)' by introducing an online payment system (sign).*

This meaning statement was considered as being ambivalent, since its concept contained both, a negative connotation in 'trying', and a positive connotation in 'catching up'. However, in contrast to the previous example, a clear recommendation for design could be derived, for example to consider evoking a stronger concept such as 'outpacing' technology instead of 'catching up'.

Whereas the first exemplary meaning statement was considered as ambivalent, since the valence was simply not clear, the second one had a positive and negative side. It is concluded that in order to facilitate a more detailed analysis of ambivalent meaning statements, the four data-driven reasons for considering meaning statements as ambivalent (see Section 4.3.4) should have been made explicit in an additional category.

It was observed that some meaning statements about different service examples shared the same concept but related it to signs through different **bases**: either causality, i.e. based on facts, or convention, i.e. social rules, habits or norms. For example, the concept 'community' appeared in relation to the services b_MS and b_P2P. According to Oxford Dictionaries (2017), which "focuses on current language and practical usage", a community is characterized by a group of people having a commonality. Therefore, it is assumed that such a commonality can be the fact, based on which a sign can be related to the concept 'community'.

Regarding the service b_MS, all three interviewees, who referred to the concept 'community' (see Section 5.2.8.1), identified the same commonality which constitutes the community: people coming together for

cycling. In turn, the relation between sign and concept was considered as being based on causality. Contrarily for the service b_P2P, a controversy was observed, whether it can be called a community (see Section 5.2.8.3). Various conventions, i.e. social rules, were reported, based on which the service can be considered as a community or not: for example, interviewees mentioned that the service allows its users to find out about someone next door or to present themselves in their online profiles, or does not allow its users to meet again after resigning. The constituting commonalities of communities was not pointed out in any meaning statement. Since there was no agreement on the concept of 'community' for the service b_P2P, it is assumed that it is still negotiated by social construction, which partly happens through the symbolic role of the service (cf. Jackson, 2005).

It is further assumed that when many conventions exist in parallel about the relation of signs and a single concept, they can give rise to conflicting meaning statements, which in turn support the conventional character of the concept. By agreeing on conventions, such as defining communities by commonalities, these agreements can shift the focus from the relation of sign and concept to the question whether the sign can be considered as a fact of the entity 'object' of the meaning statement, and in turn give rise to its associated concept.

This reflection highlights that designers should be aware of whether the basis for relating the intended sign and concept is still negotiated or has reached agreement, and whether they can take influence on the sign. It also points out the thin line between causality and convention, since one can question everything.

In research about the sharing economy, it was often assumed that peer-to-peer online services, such as the studied service example b_P2P, are based on communities (Hamari et al., 2013). In order to reach more people, the designer of the service decided to improve '*the convenience side. That is: people finding bikes available at that moment they need it*'. It is assumed that as such services aimed for the mass market the community-concept was lost. This was also described by bloggers about the sharing economy such as Rustrum (2016), who called this evolution the 'gig economy'.

It would be worthwhile to analyze the meaning statements identified in this study through coding them in **additional thematic groups** such as 'requirements on service' or 'on users', 'use cases', 'aesthetics', 'service as symbol', 'quality', and 'potential improvements'. These coded categories could then be further analyzed from the perspective of the MOSC-entities referring to the MeaningMap in order to find differences between them, which could inform the corresponding design tasks. Another analytical avenue would be to code the order in which meaning statements were made, starting from first impressions. In turn, the salience of signs, i.e. "what stands out most prominently" in perception and cognition (Chandler and Munday, 2011), could be analyzed based on the assumption that more prominent aspects of services are perceived, processed, and mentioned first.

However, even though these thematic groups were not coded, it was possible to consider some of them indirectly through the MeaningMap. For example, the 'service as symbol' was mapped by the entity sign referring to the layers 'service as a whole' or 'technical system' in the MeaningMap. In addition, it was possible to indirectly consider the 'value' of the service (Section 5.5.2), which led to the assumption that comparing services to their competitors or alternatives was especially suitable for determining their positive personal value to users and non-users, but not for their negative value.

The correlations can be reflected based on their **measure of association**, i.e. Cramer's V (see previous sections for the values and in Appendix C for an overview). It is a measure for the strength of an association independent from the sample size. However, as Brosius (1998) mentions, this measure of association can only be used to make conclusions by directly comparing it to measures of association for thematically similar

correlations. Therefore, the values reported here can only serve as benchmarks in future empirical studies. The median and average of all 61 calculated measures are 0.27 and 0.31 and provide an indication of what can be considered as strong or weak. Interestingly, some important correlations for the argumentation in this thesis only showed low values of Cramer's V: for example, the relation between making comparisons to competitors and self-referential meaning statements had with 0.08 the lowest value (N=733); and the relation between the same basis of S-C relation in intended and reconstructed meanings had Cramer's V=0.117 (N=423). Both correlations had sample sizes highly above average (N=185). Since all measures of association with higher sample sizes than average were below the average Cramer's V, the influence of the sample size on the probabilities resulting from the chi-squared test, Fisher's exact test, and Freeman-Halton test is indicated. In turn, correlations with N~20 showed the highest measures of association. However, also these correlations have to be interpreted carefully, since the impact of single interviewees is higher. Consequently, correlations with relatively high same size and relatively high measures of associations are most reliable.

Several **limitations** of the empirical study were identified: first, the descriptions of the services were already an interpretation and representation of the actual services based on what was publicly available about them, and therefore definitely had an influence on the inferences made by interviewees. Second, the provision of these descriptions artificially constructed high-involvement settings especially for non-users: i.e. the interviewees were provided with more information than there might be available to them in natural settings, which influenced their perception and interpretation of the service. Third, interviewees were framed by many questions posed and by the data collection method as such, which may have concealed specific meanings. Fourth, the research method can only capture what is consciously perceivable, processable, and expressible. To address these limitations, at least one further empirical study using various representations of service examples and different data collection methods is required.

Chapter 6 Design for Meaning

In this chapter, the empirical findings are linked to design. As the empirical study stroke new analytical avenues into meaning and extended the conception of products' and services' roles in meaning beyond the sign, the links need to be established on a fundamental level, i.e. design theory. Based on these links, it is shown that the developed tools MOSC-entities and MeaningMap can also be applied in design methods with the same scope but different coverage. In addition, several supports are suggested to designers, which can take the form of predictions, hypotheses, use cases, guidelines, recommendations, and a sequence for reasoning. The application of the tools in design methods is summarized by describing their core ideas, involved representations, procedures for their application, and their intended use, based on the ideas by Gericke et al. (2017). The results of this chapter are discussed from a broader perspective in Chapter 7.

> *Examples for illustrating the discussion are, for better readability, marked in italic and assigned to an own paragraph with increased indent.*

6.1 Linking the empirical findings to design

In order to link the results of the empirical study and their discussion to design, more specifically design theory, this section draws on the ideas of the 'mind-world dualism' [16] and of the 'direction of fit', both originating from the philosophy of mind. The former idea encompasses the separation of mental phenomena, ascribed to the mind, from the physical world. This separation goes back to ancient Greek philosophers. It is pursued in this thesis out of pragmatic reasons, since it helps conceptualizing a framework for the above-mentioned link. The second idea, 'direction of fit', builds on this dualism, and, as described by Velleman (1992), differentiates whether mind follows after the world, or the other way round. Thus, as he further pointed out, the difference between these two directions is found in whether something is "regarded as factum or faciendum, as true or to be made true" (Velleman, 1992).

Based on these conceptions, it is possible to reflect on the term 'intention', which was used so far in an indefinite manner in phrases such as: 'designers intended to convey the meaning of X'. Intentions to act are conceived by many scholars as a combination of beliefs and desires, whereas a belief is a "background condition" for a desire, as summarized by Sinhababu (2013). Thus, someone's action is intentional, when it combines an instrumental or final "desire for some goal" and a "belief about how to attain" that goal (Sinhababu, 2013). Velleman (1992) distinguishes beliefs and desires through the 'direction of fit': whereas believing is about accepting something as really true, i.e. mind-to-world direction of fit, desiring points in the opposite direction by regarding something attainable to be made true.

The design theory by Roozenburg and Eekels (1995) allows the researcher to establish several links between design and the study results, based on following ideas in their book: first, a sequence of design reasoning

[16] Also called ‚mind-body dualism'. World is preferred over body, in order to avoid misunderstanding the body as human body.

(p.68ff in their book) which is discussed in Section 6.3; second a conception and comparison of cycles for design and research [17] (see Figure 9) (p.115); and third the application of the mind-world dualism in describing the two previous points (e.g. p.33, 61 & 115). The main difference between Roozenburg and Eekels and the study results of this thesis is the focus of design activities: while Roozenburg and Eekels' considerations revolve around the concept 'function', this thesis is about the concept 'meaning'. The differences of these concepts are discussed in Chapter 7. However, it is assumed that the following links to meaning can be established anyway, as these links are based on Roozenburg's and Eekels' fundamental considerations on reasoning and methodology.

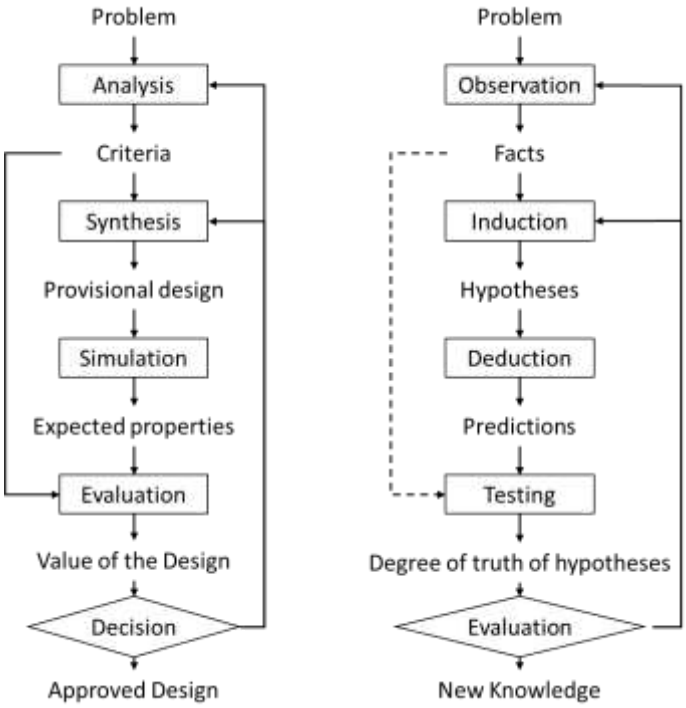

Figure 9: Design (left) and research cycle (Roozenburg and Eekels, 1995)

In the analysis phase of the design cycle, designers think about "conditions under which the thought-up world would be feasible and desirable" (Roozenburg and Eekels, 1995), or in the terminology of design for meaning: conditions under which the thought-up world would be comprehensible and significant. Roozenburg and Eekels further (1995) state that the analysis phase can be extended by the research cycle, in case designers find themselves in situations of too little knowledge. This is exactly where the results of the statistical tests in the empirical study can contribute. These results are, in the terms used by Roozenburg and Eekels, predictions about the above-mentioned conditions. They are still only predictions since they have not been tested yet in an evaluation study.

> *For example, a prediction is that designers are more likely to successfully convey their intended meanings when they relate their MOSC-entities sign and concept through causality (cf. Section 5.2.6)*

From the perspective of the mind-world dualism, the analysis phase has a mind-to-world direction of fit, i.e. making the mind fitting the world. It is stipulated that in the analysis phase, beliefs, as one part of the

[17] The interested reader is referred to their book. Here, only the relevant parts of both cycles for establishing the links to the empirical study are described.

designer's intention, are formed. Thus, the evaluated predictions, derived from the results of the empirical study, can be beliefs in the widest sense. Additionally, designers can apply a similar methodology as in the empirical study (MOSC-entities and MeaningMap) to analyze the conditions of the possible worlds: for example, by analyzing meaning statements about competitors or involved practices.

In the synthesis phase of the design cycle, designers apply creative reasoning to develop the possible world, whose conditions were analyzed before, by integrating ideas into a complete whole, resulting in a provisional design (Roozenburg and Eekels, 1995). This phase has a world-to-mind direction of fit, i.e. making the possible world fitting the mind. However, the possible world does not necessarily need to come to existence yet, but can remain in the minds of the designers, or can take form as representations such as sketches, or models. It is stipulated that in the synthesis phase, desires, as one part of the designer's intention, are formed. Thus, it requires both phases for setting intentions. In order to support the creative reasoning of this phase, the sequence of the MOSC-entities can be rearranged. This sequence is discussed in the Section 6.3.

In the simulation phase, designers gain an understanding about the expected properties of products and services by testing models of products and services (Roozenburg and Eekels, 1995). Expected properties are for example, appearance, quality, durability, operability, comprehensibility, and significance. This phase has a mind-to-world direction of fit since the designer's mind follows the simulated possible worlds. In the subsequent evaluation phase, the expected properties are compared to the desired properties, as defined in the synthesis phase and grounded on the results of the analysis phase. Designers need to judge the results of the comparison in order to decide whether they need to refine the thought-up world or can proceed with the next step towards the objectification of their ideas.

In user-centered design in general, and design for meaning in specific, designers need to take the perspective of (potential) users, in addition to the perspectives as described by Roozenburg and Eekels. Thus, as formulated by Krippendorff (2006), designers need to gain an second-order understanding. The second-order understanding especially applies to the analysis and simulation phases of the design cycle by Roozenburg and Eekels. In order to capture the perspective of (potential) users, designers can directly involve them in both phases, such as in the empirical study. It is stipulated that, from the perspective of the mind-world dualism, the involvement of (potential) users during the analysis and simulation phases entails a $mind_D$-$mind_U$-world direction of fit [18], i.e. making the mind of the designer fitting the minds of (potential) users, how they make their minds fit the world.

This $mind_D$-$mind_U$-world direction of fit has (at least) two implications for design: first, it highlights the importance of a common model of both minds facilitating the translation between them; and second, it highlights the role of the other actors than designers in the 'social construction of technology', referring to the sociological theory of the same name mainly developed by Pinch and Bijker (1984) (cf. Section 5.6.1.2).

The common models of minds in this thesis are: 1) the MOSC-entities and the derived determinants of meaning for describing inferences and the contained meanings, which designers intended and users and non-users reconstructed; 2) the MeaningMap, as the link to design, which allows researchers and designers a methodological transition between the phases - analysis, synthesis, simulation, and evaluation - of the design cycle.

For making this methodological transition, designers first identify and deconstruct meanings in products and services made by others through the MOSC-entities, and second structure them in the MeaningMap during

[18] The indices indicate whose mind is referred to: $mind_D$: the mind of the designers, or $mind_U$: the mind of the (potential) user.

the analysis or simulation phase. As a result, the designers have mapped the design space, which facilitates the designers' creative reasoning during the synthesis phase or the evaluation of the simulation again through the MOSC-entities. Basically, designers have the following options for synthesizing ideas into a complete whole:

- Starting off with the MOSC-entity 'sign', from where potential users also start with making inferences, designers can either thwart, mitigate or increase the communicative potential of an identified sign, or emphasize a new sign.
- The sign should in turn give rise to the already identified concept or draw the (potential) users' attention to another concept.

As a result, the cornerstones of an intended meaning are defined. The intention involves both, desires and beliefs. It is important to explicate implicit assumptions, which are vague beliefs during the analysis phase. In this outlined transition, the MOSC-entities and the MeaningMap are tools and part of a research and/or design method and become part of a design method during synthesis.

6.2 Application possibilities of Design for Meaning

In the following sections, the results of the empirical study for each research question are linked to design in order to inform the application of design for meaning to various ends, which are derived from the research questions of the empirical study. The results can take several forms:

- as predictions or hypotheses for the analysis phase, which in turn can be taken up in the synthesis phase. In some cases, only hypotheses were put forward, since they were derived from qualitative analysis, which do not provide the "general grounds" to deduce predictions (Roozenburg and Eekels, 1995).
- as use cases for applying the tools MOSC-entities and MeaningMap in design methods during the analysis and simulation phases;
- as guidelines for running simulations, since the empirical study can be considered as a simulation of the comprehensibility and significance of the service examples for users and non-users through a model of them, i.e. their descriptions (cf. Section 4.2.2);
- as recommendations for the evaluation of the simulations.

6.2.1 Design for successfully conveying intended meanings

The following table (Table 15) summarizes the design-relevant results for successfully conveying intended meanings.

Table 15: Predictions, hypotheses, use cases, guidelines, and recommendations for successfully conveying intended meanings per phases of the design cycle

Analysis	*Synthesis*	*Simulation*	*Evaluation*	*Results of the empirical study for successfully conveying intended meanings*	*Detailed description*	*Examples in Section*
x	(x)			Hypotheses: common association; not far to seek	Association between S&C was common since S was inherent part of service. Best if S&C can be related through causality, instead of convention. Concept was not far to seek, since derived from main purpose of service.	5.2.8.1

Analysis	*Synthesis*	*Simulation*	*Evaluation*	*Results of the empirical study for successfully conveying intended meanings*	*Detailed description*	*Examples in Section*
x	(x)	(x)		Hypothesis: Importance of visibility of signs	Analysis: explore visible signs e.g. of competitors Synthesis: have visibility in mind when choosing sign Simulation: check visibility of chosen sign	5.2.5
x	(x)	(x)		Prediction: Basis of relation between S & C: causality	Analysis & Synthesis: explore and choose causal relations of signs to concepts, especially referring to the layer 'C:people'. Simulation: check whether taken up as intended	5.2.5 5.2.6
		x	(x)	Use case: identifying and describing affordances during simulation	Meaning statements about affordances have no level of congruence. -> analyze them through MOSC-entities and evaluate whether to strengthen or weaken the service's communicative potential.	5.2.2
		x	(x)	Use case: confirmation of successful conveyance	Determination of successful conveyance: number of reconstructed meanings with high levels of congruence OR with congruent entities Recommendation: in both ways: designers get an understanding which intentions (claims) are supported by (potential) users, which intentions are more important to them, and which signs are most salient to (potential) users.	5.2.1 5.2.7 5.5.3.7

Legend:
X: phase of design cycle with main focus
(x): affected phases
S: MOSC-entity 'sign'
C: entity 'concept'
Green: MeaningMap was supportive of the analysis of the interview data

It is important to mention that two ways for determining the successful conveyance of intended meanings were used in the empirical study. Designers can choose which suits them more. Two predictions and one hypothesis are made from the empirical study, which can help designers in the analysis and synthesis phases for identifying and deciding on sign, concept, and the basis of their relation. The prediction on causality should not conceal the fact that intended meanings can also be successfully conveyed when sign and concept are related through convention. Nevertheless, designers need to be very sure about a convention and that people know it when they want to apply it. The meaning-based approach can also be used to describe affordances.

6.2.2 Design against undesired reconstructed meanings

The following table (Table 16) summarizes means for designing against undesired reconstructed meanings.

Table 16: Predictions, hypotheses, use cases, guidelines, and recommendations for designing against undesired meanings per phases of the design cycle

Analysis	*Synthesis*	*Simulation*	*Evaluation*	*Against undesired meanings*	*Detailed description*	*Examples in Section*[19]
x	x			Prediction: meaning statements whose signs and concepts are based on convention, are more likely negative	Analyze whether service can evoke signs, which can give rise to concepts based on conventions.	5.3.4
x	(x)	x	(x)	Prediction: making comparisons is important to users and non-users for determining positive personal value of services.	In contrast: significantly fewer comparisons were made for determining the negative personal value. Thus, designers do not need to consider competitors or alternatives of the service during the analysis and the simulation phases.	5.5.2
x		(x)		Hypothesis: service is **socially constructed**, which in turn influences its acceptance. (SCOT: social construction of technology)	The following indications were found in the study: - thoughts by others - what users make out of it - how service is provided - relevance to general public - concern for others Therefore, designers need to consider the social dimension during both: analysis and simulation.	5.3.1 5.2.8.3 5.2.8.4 5.3.5.1 5.3.5.3
x		x		Hypotheses & guideline: People's general perception; or their assumptions	Identify people's general perceptions or the assumptions behind their negative meaning statements through the MOSC-entities, which reflect the Mind(D)-Mind(U)-World direction of fit during analysis and simulation. Especially people's general perceptions are hard to change, and therefore these people are an out-group	5.3.5.2 5.2.8.4
(x)	(x)	x	(x) ->	Use case and guideline: identifying and describing unintended negative side effects during simulation	Identify: during simulation: negative side effects are expressed in concepts. Describe: by analyzing the underlying assumptions or beliefs made during the analysis phase; and trade-offs made during the synthesis phase. Evaluate whether they need to be addressed. Address by emphasizing other signs.	5.2.8.2 5.3.5.4 5.3.5.6
(x)		x	(x) ->	Use case: Good intention interpreted contrarily	Unintended: unexpected (based on beliefs) and undesired. In turn, designers need to revisit their beliefs and assumptions.	5.2.8.2 5.3.5.1

[19] Since meaning statements, which unsuccessfully reconstructed intended meanings (Section 5.2) were in many cases undesired (Section 5.3), research questions were overlapping and in turn, this table includes various chapter numbers.

Analysis	*Synthesis*	*Simulation*	*Evaluation*	*Against undesired meanings*	*Detailed description*	*Examples in Section*[19]
(x)	(x)		x ->	Recommendation: evaluate simulated conflicting meaning statements through conflict resolution intention	5 conflict resolution intentions (Thomas, 1992): avoid, accommodate, compete, collaborate, compromise. Questions derived from results for deciding on resolution intentions: - Is the conflicting meaning intended? E.g. to create some tension for users. - Which conflicting meaning is dominant? - Was wishful thinking (= desire in synthesis) involved? -> Is current sign suitable for evoking intended concept? If not search for another sign. - Which social groups make which conflicting meanings? (enrich statements with demographic data) -> in-group; out-group - Which actor is more powerful, in terms of resources and influence on the market and public opinion?	5.2.8.3 5.3.3
(x)	(x)		x ->	Hypotheses: designers downplayed a use case; misconceived service. Recommendation for evaluation	Hypotheses, since they were derived from qualitative analysis of the 'simulation' in the empirical study. During evaluation: in both cases, the underlying assumptions, made in the analysis phase, need to be reflected.	5.2.8.2
			x	Recommendation: choosing which conflicting meaning should be resolved first	Two decision criteria were derived from the interview data: in-between "users" and/or number of non-users stating the conflicting meaning	5.5.3.7

Legend:
X: phase of design cycle with main focus
(x): affected phases
Mind(D): in the mind of the designer
Mind(U): in the mind of the (potential) user
->: feedback loop
Green: MeaningMap was supportive of the analysis of the interview data

The most important implication of the empirical study for designing against undesired meanings is the prediction that in most cases (potential) users do not rely on making comparisons when making conflicting meaning statements. Therefore, designers do not have to make comparisons when anticipating undesired meanings, which in turn reduces the dimensions which need to be considered and the complexity.

In addition to the categories 'what', 'who', 'when', and 'where' as described elsewhere (Waltersdorfer et al., 2015a), it was unveiled in the empirical study that MOSC-entities can also fall into the category 'how'. Three stories were found: the service example b_PSS was interpreted as being imposed on the people, since it was not done with them but for them; additionally, the service was interpreted as a symbol for gentrification, since the communities of neighborhoods were not involved in defining expansion plans; and the service example b_P2P was interpreted by bike rental owners as a threat to their businesses, due to a strong media coverage. This category is especially interesting for designing against undesired meanings, since, as the examples show, when people cannot have a say about *what* is done, they complain about *how* it is done. Therefore, it is important that designers consider in addition to 'what they say, how they say it'. Considering the 'how' can inform the conflict resolution intention 'avoiding', which points already to the next section.

Thomas (1992) described five strategic conflict resolution intentions as basic choices, which he distinguished by the two dimensions of "attempting to satisfy one's own concerns" and "to satisfy concerns of others". The five intentions are: "avoiding" to satisfy anyone's concerns; „accommodating" by only satisfying only the other's concern; „competing" by only attempting to satisfy one's own concerns; „collaborating" by satisfying the concerns of both parties; and „compromising" as literally compromising about the conflicting concerns (Thomas, 1992). Guiding questions were derived from the empirical data, which support designers in choosing between these intentions.

It is assumed that the MOSC-entities are only a first shot for describing the mind of (potential) users, which do only cover a small fraction, and therefore only have explanatory power. In order to make predictions, designers need to gain a more holistic picture of the (potential) user's mind, and can rely on a vast literature about frame representation (Barsalou, 1992; Petersen, 2007).

It is predicted that intended meanings, whose signs and concepts are related through convention, are more likely interpreted negatively. In order to envisage a potential dislike of a service, designers would need to figure out which conventions they need to address. For example, they could identify conventions by their experience on social norms, by analyzing competitors, and by gathering user expectations during the analysis phase. Through the MOSC-entities, designers could deconstruct statements made by potential users in order to check whether they involve conventions. The valence of self-referential meanings statements could be considered as an indication for a potential dislike of a service. Enriching these statements by demographic data could allow designers to distinguish social groups, which could dislike the service. For addressing the identified conventions, designers could reason about which social groups these conventions would apply to, which signs were involved in these conventions, and what other signs could be involved in defying these conventions.

> *For example, one non-user of the service example w_MS (David) mentioned that adding washers to, and serving food in, a retro café (observable signs) make the whole service (object) overloaded (concept). The concept's relation to the sign is based on convention, since it is a question of social norms, whether the café can be called "overloaded".*

David's concern about the service example w_MS was based on the assumptions that the café had primacy over the other services, was already unique as such, and therefore would not need additional services to make it more attractive. Designers could reason from the analysis that the service should rather evoke the reverse sign: adding a retro café to self-service washing. One way to do so could be to emphasize the washing by assigning more room to the washing area and putting the washers closer to the shopfront. By making the primacy of the self-service washing more clearly, the concept about the café 'being overloaded' could be less likely conveyed.

6.2.3 Design for improving the communicative potential of services

In addition to the basic options for designers during the synthesis phase (see Section 6.1), the following ways for improving the communicative potential of services were identified through the empirical study and summarized in Table 17 :

Table 17: Predictions, hypotheses, use cases, guidelines, and recommendations for improving the communicative potential of services

Analysis	*Synthesis*	*Simulation*	*Evaluation*	*For improving the communicative potential*	*Detailed description*	*Examples in Section*
x				Prediction: technology- or people- centricity of services is reflected in the 'ways of inquiry'.	Designers need to figure out whether the service relies more on technology or people or both during its formation and the exchange: Technology-centricity: the layer technical system can be observed (as a way of inquiry by non-users); People-centricity: anticipation of the layer 'processes' is dominant in meaning making by non-users.	5.3.3
x				Hypothesis: it is required to enhance a service for some concepts, such as lifestyle	Enhancement of service through the sign: can be actual (impact on daily life) or imaginary (choosing over alternatives)	5.2.8.4
		x		Use case: the simulation of a service may uncover unintended aspects in design	The following unintended aspects were discussed: - designer's implicit assumptions - positive side effects (beyond use-related affordances) - powerful concepts for refining intended meanings - unintended target groups: by reflecting on their beliefs, designers need to decide, whether the target group was neglected or is undesired.	5.4.1 5.4.2 5.4.4 5.4.3

Legend:
X: phase of design cycle with main focus
Green: MeaningMap was supportive of the analysis of the interview data

For example, when comparing the service examples b_P2P and b_PSS, it turns out that the latter is purely technology-centric, whereas the first one additionally is people-centric during the service's life cycle phases ‚formation' and ‚exchange'. Therefore, designers need to emphasize both: first, making the technical system visible, which is in the case of the service b_P2P difficult, since it is purely web-based, and second, also facilitate the anticipation of the use processes, such as approaching, getting, using, returning, and leaving. For example, the service provider could install a ‚pop-up' infrastructure at hotspots in peak seasons, such as it is done with food-trucks, in order to increase the visibility of the service.

The following example is about enhancing the service w_P2P through a sign with expressive quality: a non-user (Selina) concluded that ‚it involves the risk that clothes are not properly cleaned, since one cannot know if owner properly maintains the machines'. Designers could prompt renters to specifically rate the cleanliness of the washers and show these ratings on the website. Additionally, renters could also acknowledge whether a maintenance wash was performed.

As it was shown in Section 5.2.8.4, both, the presence and the absence of addressed layers of the MeaningMap are important since they allow the researcher or designer to read the map differently: either looking for 'crowded spots' or 'blind spots'. The latter can be 'blind' in two ways: both users and non-users never referred to the specific layer of the MeaningMap, or designers did not draw their attention to it.

6.2.4 Design for meaning to foster eco-sufficient user behavior

Table 18 summarizes design-relevant results of the empirical study for designing meaning to foster eco-sufficient user behavior.

Table 18: Predictions, hypotheses, use cases, guidelines, and recommendations to foster eco-sufficient user behavior per phases of the design cycle

Analysis	*Synthesis*	*Simulation*	*Evaluation*	*To foster eco-sufficient behavior*	*Detailed description*	*Examples in Section*
x	x			Prediction: the MOSC-entity concept referring to the layer 'people' is an important condition for reconstructing meanings and influencing behavior	The following predictions were made from the empirical study, which apply to 'C:people': - causality as basis of relation is correlated to positive meaning statements about all services - causality is correlated to the successful transfer of intended meanings about b_PSS & w_P2P - positive valence is correlated to meaning statements by users about all services or only b_PSS	5.3.4 5.2.5 5.5.1
x	x			Hypothesis: the self-referential character of meaning statement is reflected by the entity concept referring to the layer 'people'. The M-B mechanisms add nuances to the concept.	The nuances are: about the customer journey (enhancing the self-concept), about the interviewee's feelings (protecting the self-concept), the relation to others, and the relation to the past. Therefore, for deciding on a M-B mechanism, designers can consider which nuances the service is best capable to evoke.	5.5.3.8
x	x			Hypothesis: different concepts of intended meanings, making use of different M-B mechanisms can be harmonized in order to reach more people.	For example, a strategy could be to: first, focus on individuals by 'enhancing their self-concepts' and second, after a threshold is reached, to focus on the mechanism 'relating to others'.	5.5.4
x	x			Hypothesis: sustainability is not easy to be conveyed or not of most relevance for both, users and non-users	Sustainability is easiest to be conveyed through inherent sustainable practices of a service, such as cycling or sharing, taking the role of the entity 'sign'.	5.5.4
x	x			Hypothesis: non-users rely more often on the M-B mechanism 'relating to the past', whereas users on 'adaptive attitude'.	Following from this hypothesis, designers need to consider prior experiences of non-users and offer ways for forming adaptive attitudes in case of unmet expectations.	5.5.3.2
x		x		Use case & Guideline: designers can make use of additional categories for users	The following categories were derived from the interview data: - potential users: showing same patterns in reconstructed meanings as users. E.g. applicable to market studies before entering new geographical markets. - pragmatic users: primacy of one M-B mechanism of another - in-between users: showing intra-personally conflicting meanings	5.5.3.5 5.5.3.6 5.5.3.7
x	(x)	x	(x)	Prediction & Guideline: making comparisons is important to users and non-users for determining positive personal value of services.	In case of focusing on positive value: Designers need to consider competitors or alternatives of the service during the analysis and the simulation phases. For example, designers could analyze the communicative potential of competitors for evoking their intended meanings. Additionally, they could include interview questions the simulation, which prompt interviewees to make comparisons.	5.5.2
		x	x	Guideline: Identifying potential users	Interviewees making positive self-referential meaning statements -> (potential) users internalized service. Real 'dedicated' non-users emphasize dislike in negative self-referential statements.	5.3.2 5.5.1 5.5.2

Analysis	*Synthesis*	*Simulation*	*Evaluation*	*To foster eco-sufficient behavior*	*Detailed description*	*Examples in Section*

Legend:
X: phase of design cycle with main focus
(x): affected phases
C: entity 'concept'
b_PSS: service example product-service system involving sharing bikes
w_P2P: service example peer-to-peer (P2P) involving sharing washers
Green: MeaningMap was supportive of the analysis of the interview data

It is important to notice the role of the MOSC-entity concept referring to the layer 'people' of the MeaningMap: it conditions several predictions about the successful conveyance of intended meanings, the acceptance of services, and the relation between meaning and behavior. Therefore, designers could especially bring this reference into focus of their design activities.

It is also predicted in case designers want to convey positive personal value to (potential) users that they need to make comparisons to competitors and alternatives. This prediction can inform value-driven design, in which comparisons are primarily made between design options in order to maximize the value of a designed system (Hazelrigg, 1998).

All meaning-behavior mechanisms, as developed in Chapter 3, were found in the empirical data and additionally specified through the following study results: they add nuances to the MOSC-entity concept referring to 'people'; they can be combined in a strategy for behavioral change; in some cases they show differences between users and non-users; and in other cases they indicate potential users, pragmatic users or in-between users.

DeGrandpre (2000) argues that the dialectical process[20] of meaning making can act as reinforcement of past behavior, when the behavior is affirmed in meaning making. This is in line with the findings by van den Heuvel et al. (2013), indicating that meaning has the potential to make a behavioral change stick, if the change was made by the person itself as this results in more stable relations. In the analyzed interview data, both the dialectical process, which was called mutual influence of meaning and behavior (Section 5.5.3.4) and one meaning statement, which indicated that the behavioral change stuck, were found.

Following the initial Meaning-Behavior Model in Figure 4, behavioral change can be related to various **interventions** by designers through meanings in products and services. Specifically, a relation between behavioral change and meaning can be established when designers intervene by

0. facilitating the interaction with a new product or service, as zero option.
I. facilitating a new way of interaction with an existing product of service, leading to new situations for meaning making.
II. stimulating different appraising meanings compared to the usual ones.
III. addressing different beliefs, goals, subjective feelings or self-views, as part of the individuals' global meaning.
IV. intentionally provoking discrepancies between appraised and global meanings, which, if not accepted, potentially result in changed appraised or global meanings through maintenance.

[20] A process, which involves the „interaction with one's social and physical world" (DeGrandpre, 2000).

V. stimulating the review of past interactions, which potentially results in changed appraised or global meanings.

It was not possible to consider these interventions in the interviews of designers, due to the study's focus on meaning transfer. In order to capture and analyze these interventions, more depth would have been required on design decisions, which was not possible due to time constraints. However, it is possible to reflect on the interventions through the meaning statements about the service examples:

The designer of the service example b_PSS explicitly intended to change user behavior, i.e. getting people bicycling more. The concepts 'gateway drug' to cycling, i.e. allowing users an easy entry, and 'normalization' of cycling, i.e. making cycling seen more normal, which were brought up by many users of the service, could be indications of the following two interventions: (I.) designers may have facilitated a new way for trying cycling, which led to new situations for meaning making and in turn new meanings about cycling, as the desired scripted behavior; (III.) designers also may have addressed the socially oriented self of potential users, as part of their global meanings, who orient themselves towards others, i.e. what they see as normal.

In addition, the designer's intention about the service w_MS - to combine the useful with the nice things - can be interpreted as a design intervention through meaning: the designer stimulated this meaning, which is different to meanings about normal laundromats (II. intervention), by additionally offering coffee, cakes, and a nice atmosphere. It would be a successful intervention, since the intended meaning was mainly successfully conveyed and one user even referred to it, when explaining why she chose this service over others.

6.3 Reasoning in Design for Meaning

Coming back to the ideas by Roozenburg and Eekels (1995, p. 74ff) on reasoning in the synthesis phase of design, they argue that designers reason from end to means in order to concretize the only premise, which is the end of their design activity. According to Roozenburg and Eekels, the designers' means are the definition of characteristics of products or services and a prescription of their actualization, i.e. required concrete actions for achieving their ends. It is suggested that the end can be something else than the concept 'function' [21], around which Roozenburg and Eekels' considerations revolve. Characteristics are attributes of products and services that designers can directly influence, whereas properties only follow from the characteristics (Andreasen, 1994). Roozenburg and Eekels (1995) call this reasoning process "innoduction". In this process, designers count on the laws of nature so that the desired end becomes true.

For transferring their ideas to design for meaning, it is assumed that the end of the design activity is one of the application possibilities as described in Section 6.2. In the following, only the end of successfully conveying intended meaning is discussed. The desired property of a product or service, for the successful conveyance of the intended meaning, is its comprehensibility and significance to users.

It is assumed that the intended meaning was already chosen from a list of promising intended meanings, as the first design decision. The list was generated by creatively coming up with text phrases, which combine the MOSC-entities 'concept' and semiotic 'object': the 'object' defines to what the meaning refers, i.e. in terms of inferences: about what the conclusion is made; the 'concept' defines the idea about the object that should be conveyed.

[21] The similarities and differences between meaning and function are discussed in Section 7.1.

During a subsequent step of innoduction, designers reason about their means for conveying their intended meanings. From the perspective of meaning, which was propagated in this thesis, the designers' means are the MOSC-entity 'sign', referring to layers of the MeaningMap, and the ways of inquiry, as prescribed actions for achieving the successful conveyance of intended meanings, i.e. its actualization. Thus, designers need to reason about possible signs, which are relevant to the (potential) user, which can either be perceived through interfacing, observing or anticipating, and which can give rise to the 'concept' and also refer to the semiotic 'object'. Additionally, it is assumed that designers count on the 'laws of meaning making', in analogy to the 'laws of nature', so that the intended meaning is successfully reconstructed by users and non-users. The bases of relation between signs and concepts are considered as the 'laws of meaning making', since they reflect whether meaning making by users and non-users was based on logic or not. In the latter case, the laws would not have been conformed to, and therefore designers could not do anything about it.

> *For example, the service provider of b_PSS decides to foster group rides (concept) for existing users with annual membership (object) in order to strengthen communities and to increase the number of rentals. During innoduction, designers ask themselves, how 'fostering group rides' can be evoked, and how the sign can be perceived. They come up with three ideas: make annual group memberships possible; enhance the phone app with a group-ride scheduling assistant; or plan cycling events on weekends where users with annual memberships can invite friends to ride for free. They decide on the third option since it is causally related to the concept and refers to the users with annual membership in object.*

As stated by Anscombe (2000), actions, such as design efforts, can be intentional only under a specific conditions, but not under another one. When it comes to intended meanings, these conditions, such as assumptions and beliefs, are reflected in the informative MOSC-entity 'situation'.

> *To take up the previous example, an assumption would be that users actually want group rides as part of cycling events on weekends. Another assumption would be that people are fine with the fact, that only users with annual memberships get the privilege to invite friends for free, since it is a reward for their loyalty. The second assumption contains another intended meaning, which might provoke some controversy.*

To complicate things, it is derived from the MOSC-entities that products and services can take four roles in meanings: as sign, concept, object, or part of the situation. It is further stipulated that products and services: are expressions or representations of something as signs; are conceived as whole ideas as concepts; are at the center of interest for the interpreter as objects; and are facilitators of meaning as being part of the entity 'situation'. Depending on which role the product or service takes, designers have more or less means to convey the intended meanings.

It needs to be highlighted that the ideas in this chapter are prescriptions, which still need to be evaluated in terms of their applicability and further in terms of their effectiveness.

6.4 Summary: the MeaningMap in design methods

For summarizing the Chapter 6, the MeaningMap, and the underlying MOSC-entities are described, based on the ideas of Gericke et al. (2017) what constitutes design methods in their point of view: its core idea, involved representations, procedure for its application, and its intended use.

At their core, the MeaningMap and the underlying MOSC-entities are tools, which concern the concept of meaning in products and services. It is assumed that meaning provides a different perspective on design than for example the concept of function. The MOSC-entities are grounded in the semiotics, more specifically, the

triadic model of signs by Peirce. The MeaningMap is comparable to a domain-mapping matrix for each MOSC-entity and builds on the idea of PSS layers by Müller et al. (2009). The MeaningMap is so far the only involved representation of meanings in products and services. The application of both tools in design reasoning draws on the design theory by Roozenburg and Eekels (1995).

Both tools can be applied in methods for Design for Meaning with the same scope but different coverage. Although the tools were developed concurrently with an empirical study on existing services and product-service systems and in turn only examples about improvements for redesigns were discussed, it is assumed that the scope of the methods can also be extended to products and as well to original designs. The extension of the scope seems feasible, since the PSS layers were defined in a way to suit all market entities, and the adaptation of the data collection for informing original designs was discussed.

The methods for Design for Meaning can cover the following problems and challenges: successfully conveying intended meanings; designing against undesired reconstructed meanings; improving the communicative potential of products and services; fostering eco-sufficient user behavior.

For all covered problems and challenges, predictions and hypotheses were made for the analysis and synthesis phases of the design cycle; use cases were highlighted for the simulation phase, in which the tools can be applied; guidelines were developed for this application during simulation; and recommendations were provided for the evaluation phase. It is envisioned that this support provides helpful insights into the problems and challenges. Procedures were developed for both: analyzing and synthesizing meaning.

The importance of the simulation phase for Design for Meaning needs to be emphasized: since people, such as users and non-users, shape technology and are shaped by it (Bijker and Law, 1992), supported by study results see (Section 6.2.2), designers need to stay open and flexible to changing meanings (Sengers and Gaver, 2006) and thus anticipate the impact of their designs on people during the simulation before its launch and also follow the evolution of meaning through further “simulations” after its launch.

It was indicated in the tables in Section 6.2, which analyses were actually supported by the MeaningMap. Whereas all analyses were based on the MOSC-entities, the MeaningMap only facilitated a few through clustering: all analyses which involved layers of services, such as made comparisons to competitors, and relations to other people.

Meanings do not necessarily have to be captured through interviews. Other data sources, such as online reviews, focus group discussions and recorded complaints, are applicable as long as they contain inferences. The MeaningMap should be applied by a designer, a marketing manager, a product manager, or an entrepreneur, since setting up its more detailed levels requires product- or service-specific knowledge. It is not recommend deriving these levels from empirical data, since it eliminates another way of reading the map: looking for 'blind spots', which were never or only a few times addressed by meanings. This way of analysis requires more data and clustering algorithms. In addition, of course, clustering also allows designers to look for 'crowded spots' on the MeaningMap.

Chapter 7 General discussion and conclusion

In this chapter, the meaning-based approach to design, developed in this thesis, is reflected from the perspectives of, and is integrated into design and design for sustainable behavior. Finally, the contributions are summarized, limitations and general reflections are presented, and further research directions are highlighted.

7.1 Specifics of Design for Meaning

As it was mentioned in the introduction (Section 1.2), meaning is an abstract concept, which is often used uncritically in design research. In order to bring some clarity into the discussion in design research, the specifics of the developed approach Design for Meaning are best discussed by comparing meaning to the following important concepts of design, which are sometimes used synonymously with meaning: function, affordance, product attributes.

According to Crilly (2010) "an artefact is assigned a **function** if it is taken to have the capacity to play some role for an agent using the artefact in some context." This broad definition of functions incorporates all the notions of functions, i.e. capacity-, goal-, and (product) behavior-related notions, as compiled by Eisenbart (2014). When performing their roles, which may include a transformation of an input to an output, artefacts contribute to the satisfaction of human goals (Crilly, 2010).

In the same way, products and services are conceived as conveying meaning, they could also be conceived as having a communicative function, i.e. having the capacity to play the role of media for designers and users in the context of communication. Therefore, it is concluded that both concepts, function and meaning, are just different glasses to look at design as communication. The following differences can be identified when comparing their definitions: whereas meaning is concerned with mental representations of possible *relationships* in which products and services can be involved, function is concerned with the possibly *performed roles* of products and services [22]. Thus, meaning focusses on *people's mentality*, i.e. by describing mental representation and inferential interpretation, and function focusses on products, services, and their components. It is suggested here that depending on the design problem or the research question, one concept is better suited than the other one. For example, when aiming at the successful conveyance of messages through products and services as media, it is assumed that the concept of meaning is the preferred choice, since it can describe the content of the message, further can conceptualize its conveyance, and finally can draw links to the media.

Brown and Blessing (2005) define **affordances** from a design-theoretical perspective as "context- dependent action or manipulation possibilities [of devices] from the point of view of a particular actor." Interestingly, the concept of affordance also describes only 'possibilities', but contrarily to function and similar to meaning, from a cognitive view. However, even though some scholars also conceive affordance as relations (Maier and

[22] Only possibly, since artefacts only have a „capacity to play some role [...]" (Crilly, 2010), leading to an uncertainty which is also found in the concept of meaning.

Fadel, 2009), the concept's focus remains on "potential human behaviors that the device might allow" (Brown and Blessing, 2005), but does not include interpretations to other ends. Therefore, it is assumed affordance is a special type of meaning, and both concepts can complement each other, for example by discussing mental models or relation modelling.

Product **attributes** are "aspects of a product itself or of its use", which are perceived by a user, and in turn shape "the user's attitude toward the product" (Pohlmeyer, 2012). In design, these attributes need to be translated into engineering characteristics and into requirements (ibid.). It is evident, that similar to the concept of meaning, attributes can also cover the user perspective. Confusion over these concepts stems in large part from the fact that both concepts can be captured by the same methods, such as the semantic differential and the repertory grid (see Section 2.1.2). Those methods are related to Saussure's **dyadic model of signs**. Thus, only when describing meaning dyadically, attributes and meaning can be equated. However, in this thesis the triadic model is preferred, since it accounts for more details. These details become apparent through the comparison to attributes: In the dyadic model, products and services are always the signifier, which are described through attributes, i.e. the signified. Additionally, the triadic model facilitates the translation of attributes into engineering characteristics: the MOSC-entities and the MeaningMap, which are based on the triadic model, can be used to describe a common model for the mind of designers, users, and non-users.

Design for Meaning is an inclusive approach. For example, the reasons for product attachment, such as passion, enjoyment, reflection of the self, performance, ad identified by Savas (2003), could be taken up as the MOSC-entity concept during design reasoning.

Another specific feature of Design for Meaning is its account of two additional concepts through **making comparisons**: value and personal significance. As it was discussed in the empirical study (Section 5.5.2), the value of a product or service, i.e. "a judgement of the relative desirability, usefulness, or worth of something" (Chandler and Munday, 2011), is determined by comparison, in the case of value, to an alternative or competitor. As it is discussed in Section 5.6.2, personal significance of a service is a special case in meaning making by comparing the appraised meaning to the self, as part of the global meaning. Both concepts make clear that comparisons are central in meaning making, and therefore Design for Meaning can inform other design approaches about significance and value.

It can be concluded that Design for Meaning, developed in this thesis, is a new and distinct but inclusive approach to design-as-communication.

7.2 Linking Design for Meaning to Design for Sustainable Behavior

As it was further mentioned in the introduction, the concept of meaning was chosen in this thesis as central concept, due to its importance in describing consumption in sociology. It is now time to link Design for Meaning and design for sustainable behavior by discussing the contribution of the former to the latter and further discussing common concepts.

First of all, by following two analytical avenues into meaning, i.e. its structure, and its role in cognition, design for sustainable behavior can benefit in general through a detailed description of meaning and its relation to behavior. This description is reflected in the MOSC-entities, the MeaningMap, and the Meaning-Behavior Model, whose application in an empirical study has yielded predictions and hypotheses for influencing behavior through meaning, and additionally five ways for designers to intervene on user behavior through meaning (Section 6.2.4).

Second, it was possible to find indications for the **relation between meaning and behavior** in the empirical study (see Section 5.5.3). Some participants constructed their personal identities based on the studied services, as it is described by the "consumption-as-meaning school". For example, one participant mentioned that she can look cool on a hip bike rented from a private person, when being abroad. Additionally, sustained behavioral change was described through one meaning statement, in which the participant reviewed a behavioral episode, as conceptualized by DeGrandpre (2000). Besides, the impact of design on the relation between meaning and behavior is indicated by two service examples (see Section 6.2.4). It seems that designers cannot directly foster behavioral change through meaning, but instead potential users need to make their own efforts in meaning making by internalizing the service, i.e. relating it to themselves in a positive way. However, designers can still support potential users in meaning making: as the empirical study shows users more often form an adaptive attitude towards the services, whereas non-users rely more often on previous experiences. By analyzing previous experiences for example with other similar services and finding ways how potential users can relate through them to the actual service, designers can facilitate meaning making by non-users. At the same time, designers can think about how new users can relate to the actual service in a different way based on an adaptive attitude once they experienced the service.

Third, it is also possible to discuss the semiotic concept of '**scripts**' and its four parts – prescriptive force, direction, scales, distribution (Jelsma, 2003) - from the perspective of the different service examples. It was assumed that the desired behavior of sharing was 'inscribed' into the studied services, since the services only *suggest* to share, i.e. exchange, use and return the shared good in working conditions, and *discourage* its misuse, such as not returning or breaking the shared good. It was inscribed on the macro scale since sharing is the main use process. However, also smaller scripts were inscribed, for example the payment option via a web app for the product-service system for washers (w_PSS). Regarding the parts 'prescriptive force' and 'direction' of the sharing-scripts, some participants of the empirical study mentioned about the service example peer-to-peer sharing of washers (w_P2P) that they would resist the whole script about going to a stranger's house for washing their laundry. For some non-users of the same service, the scripts were too little prescriptive, since they were concerned about the hygiene of the washer, or since too little information was required by owners of washing machines. It is striking that the P2P-sharing services show a completely different 'distribution of tasks, responsibilities, and power' than the other types, due to the involvement of three actors: the users, the owners of the shared good, and the company as mediator. These distributions and its implications were often addressed by the participants but not always clearly communicated through the services. For example, it was not perceivable for users that the b_P2P company checks the plausibility and authenticity of every listed bike before making it public. The distribution of tasks and responsibilities also led to different situations for the service exchange and use. These situations require closer social interaction than in normal consumption scripts, which many potential users anticipated as unusual and in turn disturbing.

Fourth, regarding the **eco-sufficient behavior**, the personal perspective, as demanded in literature, was captured in self-referential meaning statements. However, it is assumed that sustainability was of minor importance for the participants, since intended meanings, which covered ideas of sustainability, were less often addressed than the other intended meanings. By comparing the service examples, insights were gained how sustainability was evoked differently (Section 5.5.4). Instead of sustainability, it was more important for users of washer sharing services to have access to a washer, which is close, and for users of bike sharing to have variety (b_P2P), and flexibility (b_PSS). No user of the service b_MS was interviewed. Therefore, it is hypothesized that eco-sufficient behavior can be more likely fostered through evoking other, for example self-referential, meanings based on personal gains than meanings based on sustainability. It has to be noted

that most covered services were only used in specific cases. Washer-sharing services were adopted, when: participants live in a flat, which is too small, or has no hookup for a washer; or the landlord does not allow the tenants to have a washer. Bike-sharing services were used: for example, when travelling or for one-way trips. Only the example b_PSS was integrated into daily routines by some interviewed users. No conclusion can be made whether the studied services really decreased the resource-intensity of the users' lifestyles. However, this was never the aim of this thesis.

Finally, the relation between meaning, evoked by the studied **service examples**, and user behavior is discussed from the perspective of their **characteristics**, as described in Table 7 (see Section 4.1.2). The involvement of users in the formation of the P2P-service led to the distribution of tasks, responsibilities, and power mentioned in the section about scripts. Through that, this type of sharing comes closest to Reichel et al.'s (2009) conception of close networks of production and consumption.

Two service examples for sharing washers involve social interaction during the exchange and use phases but through different interfaces: the service w_P2P requires from its users to make a first contact through the web platform, whereas the service w_MS grants users the freedom to choose whether they want to step into a face-to-face interaction with the service worker or not. A further different characteristic between both service examples is the support for sharing: the P2P-platform only acts as intermediary; the service example w_MS provides additional services to offering washers, such as serving coffee and organizing event. Judging from the reconstructed meanings in the empirical study, the approach to sharing taken by the company w_P2P was far more controversial than the approach taken by the company w_MS, for example due to a lack of provided trust building mechanisms. Contrarily, for most participants it was clear that the service w_MS tries to make a chore enjoyable.

In the same manner, the two sharing types P2P and MS for bikes also involve social interaction, but through different interfaces. Judging from the reconstructed meanings by users and non-users, trust was no issue for the service example b_P2P, since the designers obviously included enough trust building mechanisms, as a support for sharing. However, as observed in the interviews, another characteristic gained importance for the social interaction between users: the ownership of the shared good. The shared bikes are owned by the company for the service b_MS but owned by individuals for the service b_P2P. In turn, the service example b_P2P was controversially interpreted by many users and non-users, whether it can be considered as a community or marketplace. In comparison, it was clear to most participants that the service example b_MS fosters a community, due to its café, as additional interface. This comparison highlights that the meaning of these services as communities is socially constructed.

In summary, it becomes evident that the sharing type MS, by following a people-centric approach, reflected in its interfaces, and the social interaction, was clear to most participants. In contrast, the sharing type P2P runs into troubles when pursuing a combination of both people- and technology-centricity. In the end, it depends on how these troubles, i.e. conflicting meanings, are resolved. In Section 6.2.2, five intentions for conflict resolution are described from literature. Depending on the agreed meanings, different social groups may be attracted to the services.

Additionally, the question about which service fosters communities highlights, that "it is the medium that shapes and controls the scale and form of human association and action" (McLuhan, 1964). This observation led McLuhan to his famous phrase that "the medium is the message". Such as the electric light, as medium, shapes the scale and form of human association, i.e. social ties, by eliminating "time and space factors" (McLuhan, 1964), also the studied service examples act as medium and shape social ties by applying a people-, and/or technology-centric approach. For the empirical study, the services are conceived as communicative

media for conveying meaning from a micro perspective. McLuhan adds a macro perspective on media by highlighting their social implications. In turn, the macro perspective can increase the awareness by designers of the social implications of their developed products and services. However, the social implications are not predetermined: as already emphasized, products and services need to go through a process of social construction in which their meanings are negotiated (see Section 2.2.2) in order to be accepted and adopted.

Having the social construction of technology, and the macro-perspective on media in mind, it is possible to reflect on Thorpe's (2010) proposal, mentioned in the introduction, to create alternatives to the dominant meaning structure maintained by commerce in order to overcome consumerism. Indeed, all studied services are driven by commerce, however, they all could have been run, for example, as a community-governed cooperative in order to break free from profit seeking, and accordingly become Ostrom's (2010) fourth type of good, i.e. common-pool goods, next to private, public and club goods. The service example b_PSS comes closest to Thorpe's proposal, since it is run by the local municipality, which, as mentioned in the interview, aims at maximizing bike trips over profit.

The point raised here is about power struggles in the social construction of technology. In the end, the success of alternatives lies in their human, financial, ideational, material, and time resources for facing power struggles with proponents of the dominant economic logic, and institutional constraints such as regulations and infrastructure. For example, the service example b_PSS had an advantageous position in these power struggles, since the local municipality could derestrict its use by additionally introducing new bike lanes. However, seen from the macro perspective, also first less powerful attempts can have an impact through their mere existence and the creation of possible alternative realities. It is envisioned that by following the meaning-based approach to design, designers can identify potential conflicting meanings during simulation, analyze the captured meanings, and adjust the provisional design accordingly.

It can be concluded that the development of Design for Meaning did not lead to an isolated approach to design for sustainable behavior but can be linked to the "consumption-as-meaning" school and behavioral scripting, can contribute to the discussion on eco-sufficient user behavior, and can capture both a micro- and macro-perspective on products and services in order to simulate, describe and react on the social implications and the social construction of products and services.

7.3 Summary of contributions and their implications

As it was stated in the introduction, meaning in design is vastly underexplored. It can be concluded that this thesis shed some light on the concept of meaning in design and its relation to user behavior in order to support designers in fostering eco-sufficient user behavior. To that end, different analytical avenues into meaning were compiled and two were chosen, since they looked most promising. Literature studies into meaning, approaches, and topics in design and in design for sustainable behavior, which involve meaning yielded further insights for specifying the research questions and framing the empirical investigation. A further literature study was run in order to describe the relation between meaning making and behavior, which resulted in a model, the Meaning-Behavior Model. The discussion of the empirical findings were synthesized into a set of different supports for designers comprising of four different ends to which Design for Meaning can be applied, based on a comparison to the design theory by Roozenburg and Eekels (1995). In addition, a sequence for reasoning in Design for Meaning was developed, based on the same comparison. Finally, the meaning-based design approach was discussed from the perspective of existing concepts in literature in order to embed it in design theory and in design for sustainable behavior.

Table 19 provides an overview of the main contributions made in this thesis. They can be distinguished by the types: scientific, methodological, and practical contributions, and are described in the following in conjunction with their implications.

Table 19: Overview of main contributions

Main chapters	*Sections*	*Main contributions*
2: Background	1. Meaning 2. Meaning in design 3. Meaning in design for sustainable behavior	• List of analytical avenues into meaning • Compilation of determinants of meaning • Definition of underexplored area
3: The relation of meaning and behavior	1. Meaning reconstruction by users and non-users 2. Its relation to behavior 3. Meaning-Behavior Model	• Development of a model, comprising meaning making and its link to behavior • Synthesis of 5(+1) meaning-behavior mechanisms
4: Characteristics of the empirical study	1. Background 2. Method 3. Data analysis	• Definition of PSS • Description of a life cycle applying to products, services, and PSS • Description of types of eco-sufficient behavior • Compilation of three sharing types and their characteristics • Operationalization of determinants of meaning, such as MOSC-entities, level of congruence, MeaningMap, basis of relation, meaning-behavior mechanisms, etc.
5: Empirical findings	2. The successful transfer of meaning 3. The acceptance of services 4. Service improvements 5. Differences between users and non-users 6. Summary	• All quantitative and qualitative findings • Assessment of inter-rater reliability
6: Design for Meaning	1. Linking findings to design 2. Application possibilities 3. Reasoning in Design for Meaning	• Description of MOSC-entities and MeaningMap as tools in design methods: a common model for the minds of designers and users, facilitating the transition between analysis and synthesis • Deriving predictions, hypotheses, use cases, guidelines and recommendations from empirical findings • Development of sequence for reasoning in Design for Meaning
7: Discussion and conclusion	1. Specifics of Design for Meaning 2. Link to design for sustainable behavior	• Comparison of meaning to function, affordance and product attributes • Highlighting the importance of considering the social construction of technology during design, for example through Design for Meaning

7.3.1 Scientific

The list of analytical avenues into meaning was the starting point for the scientific contributions. For the first time, Peirce's triadic model of signs was applied in an empirical study to describe inferences in design research and covered both sides of the communication process by also analyzing meaning's role in cognition. Many scholars assume that products and services always take the role of the sign when they are described through semiotics. However, as it was first argued elsewhere (Waltersdorfer et al., 2015a), the empirical data supported that they can take four different roles in inferences and the contained meanings: as sign, as object, as concept, and as part of the situation. When product and service are the concept or part of the situation, they are mediators or facilitators of inferences.

Through the four roles of products and services in meaning, it is possible to develop more detailed classifications of meaning than the popular distinction between functional and symbolic meaning. The determinants of meaning, their operationalization, and the identification of underexplored areas can lead to more empirical studies into meaning.

The concept of meaning was integrated into design theory through making comparisons to other concepts and reasoning in design, which can facilitate its further exploration. In the empirical study, it was possible to find indications for the social construction of technology, whose importance was discussed for fostering behavioral change. In preparation of the empirical study, a definition of product-service systems was developed, and a product and service life cycle and different types of eco-sufficient behaviors were described, which an also inform further explorations.

7.3.2 Methodological

Methodological contributions were made regarding the empirical investigation of meaning, which can be used in both design research and design practice or even in other scientific fields such as sociology: first through the operationalization of determinants of meaning and second in the analytical procedure of statistically testing qualitatively analyzed empirical data. The investigation yielded two new tools to be used in research and design methods: the MOSC-entities and the MeaningMap. Emphasis was placed on giving a symmetrical account on user behavior by interviewing both users and non-users of the studied services. It was possible to derive more categories for both groups from the empirical data.

By starting the investigation into meaning from deconstructing inferences, as the process of moving from premises to conclusions, and equating conclusion with meaning, essentially no occurrence of meaninglessness was observed. Consider the following example: if an interviewee responds ‘it makes no sense to me’, the designer or researcher simply probes the interviewee by asking why several times, until the interviewee arrives at a conclusion with which the designer or researcher can work.

7.3.3 Practical

Contributions to design practice were made in the form of predictions based on the statistically tested qualitatively analyzed empirical data. These are only predictions, since they were not tested and evaluated yet, in order to become a scientific truth.

It is assumed that the tools MOSC-entities and MeaningMap can facilitate the transitions between the analysis, synthesis and simulation phases of the design cycle. Based on the finding that participants do less often rely on making comparisons for negative than for positive personal meaning statements, it is assumed that the meaning-based approach can contribute most to design against undesired reconstructed meanings, since it has the fewest overlaps with other concepts for this application possibility. This is also how designers can exert influence on this process of social construction, i.e. by identifying conflicting meanings in products and services, and strengthening or weakening the potential of products and service to communicate one of the conflicting meanings.

Another practical implication of Design for Meaning is that it allows designers to integrate other scientific results, such as the conflict resolution intentions by Thomas (1992).

Additionally, the meaning-based approach to design-as-communication can support designers in evaluating the results of simulation during design: whether (potential) users support the intended meanings in the developed service, and which intended meanings in the service are more important to them. Specifically, the

MOSC-entities allow designers to carve out differences in the perception and conception of the service, and the meaning-behavior mechanisms can guide designers in ranking their importance.

7.4 Limitations

It is emphasized that due to the low inter-rater reliability for coding the MOSC-entity 'object', results of the empirical study, and derived design supports need to be interpreted with care. The assessments of the inter-rater reliability also highlighted that the research method requires several hours of training and preliminary applications in order to gain experience, and to speed up the analytical procedure. Otherwise only analyzing 6-10 meaning statements per hour, as observed in the judges, who had little experience, would be too slow, especially when hundreds of statements should be subsequently statistically tested.

For many correlations in the empirical findings, it was not possible to conclude about the causal direction of influence (see Appendix C). For example, it could be that users showed more often positive meaning statements than non-users, because they were users, or they became users because of finding positive meaning in the discussed service. Also other scientific areas are faced with this constraint such as cognitive dissonance theory (Jackson, 2005).

The tables in Section 6.2 highlight that the MeaningMap was not always supportive to the analysis of the interview data (green color code). It contributed most to derive predictions and hypotheses for fostering eco-sufficient user behavior. The MOSC-entities underlie all analyses. The role of the MeaningMap during the synthesis phase still needs to be evaluated. It is envisioned that it will gain importance, due to its applicability for making visualizations.

It is highlighted that the derived predictions from the empirical study still need to be evaluated in terms of their applicability and further in terms of their effectiveness in order to be considered as true. Due to time limitations, it was not possible to run an evaluation study for this thesis.

Due to the collection of data about existing services aiming to determine the level of congruence between intended and reconstructed meanings, which is a typical question of the simulation phase of the design cycle, it was only possible to derive design improvements from the findings (Chapter 5) and describe them through the tools MOSC-entities and MeaningMap. In order to illustrate original designs, interview studies require different interview questions, for example about competitors. However, it was possible to make some predictions from the study results, which were not service-specific.

One general limitation of Design for Meaning as one approach to design-as-communication, is its reliance on data from users or non-users, which constrains what parts of products and services designers can actually work on, since this data only covers what users and non-users can perceive, process and express. However, this can also be an advantage: through the MOSC-entities as common model for the mind of designers, users and non-users, the 'voice-of-the-customer' can potentially be translated to design easily. Additionally, designers would need to apply standard methods in order to fulfil expected functions.

7.5 Reflections and further research

Basically, the concept of meaning, as it is considered in this thesis, is a derivation of inference. In turn, meanings are extended by the question « why », which unveils their premises. Since the inferences were collected through interviews, the starting point for the semiotic-inspired analysis was common language, instead of a product or service as the subject of semiotic descriptions. The extension of meaning through

inference has never been methodologically used in an empirical study in design and consumer research, and therefore yielded interesting insights into the transfer of meaning and its relation to behavior. Additionally, thinking in mental representations of possible relationships, i.e. meaning, of which products and services can be a part, provides a distinct perspective on design.

During the coding of the empirical data, an interpretive style was pursued, which was closely oriented to the text and therefore left little room for other interpretations. This style requires from the researcher to empathize with the interviewee in order to answer questions such as 'what does the interviewee perceive?' (->sign) or 'what is important to him/her?' (-> object). Compared to previous publications, in which only literature studies were reported, the empirical study leveraged the understanding of meaning. Therefore, empirical studies are highly recommended to any researcher interested in meaning.

Further research is needed to for example, describe the 'minds' of both designers and users in more detail through cognitive frames and schemata. Additionally, the process of meaning making and the interventions on behavior through meaning in products and services, both described by the Meaning-Behavior Model, can be integrated more strongly into next empirical study designs. As already mentioned, also the derived predictions and hypotheses need to be evaluated in order to further support design practice. For evaluation, the Design for Meaning approach must be compared to other approaches to analyzing the voice of the customer and simulating their responses to a product or service. Finally, many factors described in the qualitative results, such as the identified 'powerful concepts', can be operationalized in order to be statistically tested in further investigations.

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Appendix A: Studied service examples

W_P2P: Washer rental trough online platform

Business Model

Company connects X washing machine owners and renters through an online platform for free.

Availability

Area: Mainly cities

Time: Depending on owner

Pricing

Defined by owner of washing machine.

Payment

Payment per wash and in advance.

Prerequisites for use

Online registration

Process of use

1) Through platform: Contact owner to request desired washing machine.
2) Schedule meeting
3) Go to the owner's place
4) Pay owner and wash

Support

Online platform:

- Showing washing machines, owner profiles, and approx. location.
- Owners indicate if they provide coffee, a dryer, and an iron.
- Owners also indicate if they are open for chatting, smoking, and/or drinking coffee.

Washing machines

- Washing machines are owned by private persons.
- Washing machines are categorized online by capacity

Example of listed washing machine

Picture was left out due to data protection

Search results

Picture was left out due to data protection

W_PSS: Internet-supported Laundromat

Business Model

Company provides washing machines and dryers for self-service that can be operated through the internet.

Availability

Area: close to other shops

Time: 24/7

Pricing

Washing: depending on machine's capacity, same price for different temperatures.

Payment

Payment in advance

Prerequisites for use

Without internet: coins

When operated through the internet:

- Registering an online account / Log-in
- Credit Card
- Topping up account with credit

Process of use

Internet-enabled self-service:

1) Load machine.
2) Choose machine online.
3) Enter service code of machine online.
4) Pay online by charging account.
5) On the machine: select temperature and press "Start".

Support

Laundromat:

- Detergent is automatically dispensed.
- A money changer is available
- Free Wi-Fi at the laundromat

Online account:

- Shows account balance of user, and history of usage.

Washing machines

- Washing machines are owned by the company.

Laundromat: interior view

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Online account:

Picture was left out due to data protection

View of one machine online:

Picture was left out due to data protection

W_MS: Laundromat with coffee shop

Business Model

Company offers self-service washing machines and dryers in a coffee shop, which is also an event venue.

Availability

Area: Coffee shop in a city

Time: X am – Y pm

Pricing

Pay per wash/dry

Payment

Payment in advance.

Prerequisites for use

-

Process of use

Self-service washing machines: loading machines, choosing program, paying, unloading.

Support

- Coffee shop, serving breakfast, toasts, salads, and cakes.
- Event venue.
- Retro furniture and gadgets
- Free Wi-Fi.

Washing machines

- Washing machines are owned by the company.

Laundromat area:

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Seating area:

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Coffee area:

Picture was left out due to data protection

B_P2P: Bike rental through an online platform

Business Model

Company connects bike owners and renters through an online platform. Retains a fee from the price of every successful rent.

Availability

Area: Mainly cities in western countries
Time: Depending on owner

Pricing

Defined by bike owner. Hourly, daily, or weekly basis.

Payment

In advance by credit card

Prerequisites for use

Online registration, credit card

Process of use

1) Through platform: renter searches for bikes, requests desired bike for a specific date and period from owner.
2) Clarifying availability with owner.
3) Scheduling a meeting.
4) Confirming and payment.
5) Meeting at agreed places for handovers.

- Rating each other is possible for building reputation.

Support

online platform:

- Showing available bikes, bike types, frame size, approx. locations, owners' profiles with ratings, the last time they were online and their response time.
- Listing extras such as locks, lights, helmets, that come with the rent.
- Possible verification of online identity

The rent comes with an insurance.

Bikes

Bikes are owned by private persons.

Example of listed bike:

Picture was left out due to data protection

Map of available bikes:

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Example of bike owner profile:

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B_PSS: Local bike rental system

Business Model

Company provides X distinctive bikes for rent in a city at Y stations (each station with docks and a kiosk).

Availability

Area: City

Time: 24/7

Pricing

Half-hourly basis. First 30 min are free. Additional membership fee.

Payment

After use depending on time.

Prerequisites for use

Swipe credit card at kiosk for a short-term membership. Sign-up online as long-term member

Process of use

Self-service

1) Find available bikes online, or on the smartphone app.
2) Rent a bike at a station's kiosk with your credit card or member key card.
3) Once rented, the bike gets automatically unlocked.
4) Return the bike to a station. A green light at the dock flashes once the return is completed.

Support

Smartphone App and online platform:

- Show available bikes and empty docks at each station.
- The app allows navigation and search for local businesses and comes with a timer and alarm.

Bikes

- Bikes are owned by the company.
- Bikes have several speeds, a hub dynamo, and a bell

Bikes at a station with docks and a kiosk:

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Map of stations in city area:

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Smartphone app:

Picture was left out due to data protection

B_MS: Bike café and bike rental

Business Model

Company runs a bike workshop, a coffee shop and offers bikes for rent.

Availability

Area: City

Time: opening hours: X am – Y pm

Pricing

Half day, full day, or several days.

Payment

Payment at the shop before renting.

Prerequisites for use

Pre-booking is recommended.

Process of use

1) Optional: reserve a bike by phone or email.
2) Employee adjusts seat height and handlebar to user.
3) A copy is made from renter's ID card.
4) Return within opening hours.

Support

- The rent includes a helmet
- The café also serves sandwiches, soups, salads and seasonal specials.

Bikes

- Bikes are owned by the company.
- Different types of bike available: hybrids, road bikes, tandems, kids' bikes, child trailers.

Interior view:

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Exterior view:

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Example of hybrid bike for rent:

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Appendix B: All layers of the MeaningMap

Layer 1	*Layer 2*	*Layer 3*	*Layer 4*	*Layer 5*
service as a whole	As a whole bundle			
	parts	cafe/bar		
	parts	rental: bike/washer		
	parts	other services		
processes	general principles	contact with people	direct	
		contact with people	not in person	
		contact with people	indirect & non-synchronous	
	customer journey	for coffee service		
		for other services		
		for a combination of services		
		for rental: bike/washer	approaching	
			getting	
			using	un-/desired behavior
				involved practice
				duration
				area
			returning	
			leaving	
	Support	control		
		operations		
		maintenance		
		consulting		
		complaint management		
		billing		
people	involved	service workers	roles, task	
		service workers		
		owner		
		partner		
		user	users in general	
			another user	
			type	lister
			type	renter
			relations / interaction	
			requirements, prerequisites	
			states	physical / health
			states	mental
			states	financial

Layer 1	*Layer 2*	*Layer 3*	*Layer 4*	*Layer 5*
			resources	time
			responsibility	
			customer processes	
			other relevant aspect	
	affected	peers of user		
		neighborhood		
		general public		
		excluded people		
	interface	real	rented good	
			number of goods	
			accessories	access token
			pro-sharing characteristics	
		virtual	app	
			website	
Technical system	infrastructure	real	service space	interior
			service space	exterior
			food and drinks	
			bike racks	
			kiosk	
		virtual	databases, algorithms	
			website	
			rental management system	user accounts
	user's physical resources	operative, processible, workable		
		supportive		
Context of service	directly influenceable	when	operating hours	
			service frequency	
		where	operating area	
			location	
			areal distribution	
		steps in life cycle of service	Previous to exchange	
			Following the exchange	
	not or only indirectly influenceable	competitors, alternatives		
		history or collective public memory		
		culture		
		natural environment		
		other practices		
		another techn. system		
		another entity		

Layer 1	*Layer 2*	*Layer 3*	*Layer 4*	*Layer 5*
business model	company			
	purpose			
	key partners	supplier		
	revenue streams			
	key resources	corporate culture		
		legal		
		financial		
	cost structure			
	key activities			
	channels			
	customer relationships			

Appendix C: Overview of quantitative results

RQ of ES	Section	all covered services	condition 1	condition 2	condition 3	condition 4	independent variable	and its values (top cell: 1st value)	(assumed) direction of influence (x: no correl.)	target (contingent) variable	and its values	Number of occurrences columns: moderating variable (left: 1st value)			applied stat. test	p	value	df	N	Cramer's V
	5.1	yes					interviewee being prompted to infer designer's intention	yes	->	level of congruence	full congruence	21	29		chi²	1.31E-12	64.7	5	554	0.342
											high congruence	68	109							
											medium congruence	35	77							
								no			low congruence	3	17							
											incongruence	13	121							
											conflicting incongruence	0	61							
	5.1						interviewee being prompted to infer designer's intention	yes	(->)	self-referential meaning statement	no (-> general statement)	141	374		chi²	2.19E-07	26.9	1	605	0.211
								no			yes	2	88							
	5.1						interviewee being prompted to infer designer's intention	yes	->	Valence of reconstructed meanings	positive	0	84		chi²	5.2E-08	33.5	2	554	0.246
											neutral or ambivalent	115	268							
								no			negative	25	62							
RQ2a	5.2.1		made by user				self-referential meaning statement	no	by chance?	successful reconstruction	yes (full, high, med)	80	22		chi²	0.042329	4.1	1	129	0.179

RQ of ES	Section	all covered services	condition 1	condition 2	condition 3	condition 4	independent variable	and its values (top cell: 1st value)	(assumed) direction of influence (x: no correl.)	target (contingent) variable	and its values	Number of occurrences columns: moderating variable (left: 1st value)			applied stat. test	p	value	df	N	Cramer's V
								yes			no (low, no, conflicting)	16	11							
RQ2a	5.2.1		made by non-user				self-referential meaning statement	no	by chance?	successful reconstruction	yes	221	21		chi²	0.033694	4.5	1	432	0.102
								yes			no	161	29							
RQ2a	5.2.1		made by user	not being prompted to infer intention			self-referential meaning statement	no	x	successful reconstruction	yes	38	21		chi²	0.646712	0.2	1	86	
								yes			no	16	11							
RQ2a	5.2.1		made by non-user	not being prompted to infer intention			self-referential meaning statement	no	x	successful reconstruction	yes	137	19		chi²	0.230978	1.4	1	328	
								yes			no	143	29							
RQ2a	5.2.1	x	made by non-user	not being prompted to infer intention	only for w_P2P		self-referential meaning statement	no	(->)	successful reconstruction	yes	46	5		chi²	0.025117	5.0	1	103	0.221
								yes			no	38	14							
RQ2a	5.2.1	x	made by non-user	not being prompted to infer intention	only for w_P2P	MeMa O:people	self-referential meaning statement	no	(->)	successful reconstruction	yes	16	1		Fisher's exact	0.0281		1	41	0.363
								yes			no	15	9							
RQ2a	5.2.2	x	b_P2P				use	user	(<->)	successful reconstruction	yes	26	39		chi²	0.047149	3.9	1	92	0.207
								non-user			no	5	22							
RQ2a	5.2.2	x	w_MS				use	user	(<->)	successful reconstruction	yes	36	43		chi²	0.003479	8.5	1	99	0.294
								non-user			no	2	18							
RQ2a	5.2.2	x	b_PSS				use	user	(<->)	successful reconstruction	yes	14	20		chi²	0.044085	4.1	1	98	0.203
								non-user			no	14	50							
RQ2a	5.2.2	x	b_PSS	MeMa S:tech.sys			use	user	(<->)	successful reconstruction	yes	8	1		Fisher's exact	0.00976		1	20	0.616
								non-user			no	3	8							
RQ2a	5.2.4	yes	made by non-user				way of inquiry	anticipating	x		yes	152	90		chi²	0.40426	0.7	1	434	

RQ of ES	Section	all covered services	condition 1	condition 2	condition 3	condition 4	independent variable	and its values (top cell: 1st value)	(assumed) direction of influence (x: no correl.)	target (contingent) variable	and its values	Number of occurrences columns: moderating variable (left: 1st value)			applied stat. test	p	value	df	N	Cramer's V
								oberving		successful reconstruction	no	128	64							
RQ2a	5.2.5		(made either by users or non-users)				reconstr M's basis of rela. betw. S & C	causality	(->)	successful reconstruction	yes	216	117		chi²	0.001729	9.8	1	538	0.135
								convention			no	105	100							
RQ2a	5.2.5		not being prompted to infer intention				reconstr M's basis of rela. betw. S & C	causality	(->)	successful reconstruction	yes	139	67		chi²	0.000285	13.2	1	394	0.183
								convention			no	93	95							
RQ2a	5.2.5	x	(not being prompted to infer intention)	b_PSS			reconstr M's basis of rela. betw. S & C	causality	(->)	successful reconstruction	yes	27	9		chi²	0.009111	6.8	1	62	0.331
								convention			no	11	15							
RQ2a	5.2.5	x	(not being prompted to infer intention)	w_P2P			reconstr M's basis of rela. betw. S & C	causality	(->)	successful reconstruction	yes	40	29		chi²	0.006023	7.5	1	98	0.277
								convention			no	8	21							
RQ2a	5.2.5	x	not being prompted to infer intention	b_PSS	MeMaC:people		reconstr M's basis of rela. betw. S & C	causality	(->)	successful reconstruction	yes	14	5		chi²	0.005232	7.8	1	37	0.459
								convention			no	5	13							
RQ2a	5.2.5	x	not being prompted to infer intention	b_PSS	MeMaS:processes		reconstr M's basis of rela. betw. S & C	causality	(->)	successful reconstruction	yes	20	5		Fisher's exact	0.03284		1	34	0.440
								convention			no	3	6							
RQ2a	5.2.5	x	not being prompted to infer intention	w_P2P	MeMaC:people		reconstr M's basis of rela. betw. S & C	causality	(->)	successful reconstruction	yes	19	4		chi²	0.010022	6.6	1	54	0.350
								convention			no	15	16							
RQ2a	5.2.5	x	not being prompted to infer intention	w_P2P	MeMaS:processes		reconstr M's basis of rela. betw. S & C	causality	(->)	successful reconstruction	yes	19	2		chi²	0.003867	8.3	1	43	0.441
								convention			no	11	11							
RQ2a	5.2.6	yes					intended M's basis of rela. betw. S & C	causality	->		causality	156	101		chi²	0.016006	5.8	1	423	0.117

RQ of ES	Section	all covered services	condition 1	condition 2	condition 3	condition 4	independent variable	and its values (top cell: 1st value)	(assumed) direction of influence (x: no correl.)	target (contingent) variable	and its values	Number of occurrences columns: moderating variable (left: 1st value)			applied stat. test	p	value	df	N	Cramer's V
								convention		reconstr M's basis of rela. betw. S & C	convention	81	85							
RQ2a	5.2.6		intended M: S-C: causal				reconstr M's basis of rela.: same as intended	yes	->	successful conveyance	yes	138	63		chi²	0.029745	4.7	1	237	0.141
								no			no	18	18							
RQ2a	5.2.6		intended M: S-C: convent				reconstr M's basis of rela.: same as intended	no	->	successful conveyance	yes	84	60		chi²	0.040943	4.2	1	186	0.150
								yes			no	17	25							
RQ2a	5.2.6		intended M: S-C: causal	made by non-user			reconstr M's basis of rela.: same as intended	yes	->	successful conveyance	yes	103	52		chi²	0.033957	4.5	1	189	0.154
								no			no	16	18							
RQ2a	5.2.6		intended M: S-C: causal	made by user			reconstr M's basis of rela.: same as intended	yes	x	successful conveyance	yes	35	11		Fisher's exact	1		1	48	
								no			no	2	0							
RQ2a	5.2.7						reconstr M's basis of rela. betw. S & C	causality	->	MOSC-entity: concept	congruent	55	25		chi²	0.002308	9.3	1	112	0.288
								convention			conflictingly incongruent	12	20							
RQ2a	5.2.7						reconstr M's basis of rela. betw. S & C	causality	x	MOSC-entity: sign	congruent	30	19		Fisher's exact	0.52567		1	61	
								convention			conflictingly incongruent	6	6							
RQ2a	5.2.7						reconstr M's basis of rela. betw. S & C	causality	x	MOSC-entity: both sign and concept	congruent	31	16		Fisher's exact	0.40295		1	54	
								convention			conflictingly incongruent	3	4							
RQ2a	5.2.7		intended M: S-C: causal				reconstr M's basis of rela. betw. S & C	causality	->	MOSC-entity: concept	congruent	33	12		Fisher's exact	0.03247		1	56	0.310
								convention			conflictingly incongruent	4	7							
	5.2.7							causality	x		congruent	22	14		chi²		2.8	1	57	

RQ of ES	Section	all covered services	condition 1	condition 2	condition 3	condition 4	independent variable	and its values (top cell: 1st value)	(assumed) direction of influence (x: no correl.)	target (contingent) variable	and its values	Number of occurrences columns: moderating variable (left: 1st value)			applied stat. test	p	value	df	N	Cramer's V
RQ2a			intended M: S-C: convent				reconstr M's basis of rela. betw. S & C	convention		MOSC-entity: concept	conflictingly incongruent	8	13			0.093203				
RQ2b	5.3.1						thoughts made by	interviewees	(<->)	Valence of reconstructed meanings	positive	478	8		Fisher's exact	0.00158		1	601	0.147
								others			negative	106	9							
RQ2b	5.3.1	all services					having reported thoughts by others in	only positive	(<->)	Valence of their own reconstructed meanings	positive	66	82		chi²	0.01001	6.6	1	182	0.191
								only negative			negative	7	27							
RQ2b	5.3.2	yes	no successful reconstruction of an intended meaning				self-referential meaning statement	no	x	Valence of reconstructed meanings	positive	70	15		chi²	0.322926	1.0	1	169	
								yes			negative	64	20							
RQ2b	5.3.2		no successful reconstruction of an intended meaning	made by non-user			self-referential meaning statement	no	(<->)	Valence of reconstructed meanings	positive	58	7		chi²	0.046428	4.0	1	146	0.165
								yes			negative	62	19							
RQ2b	5.3.2		no successful reconstruction of an intended meaning	made by user			self-referential meaning statement	no	x	Valence of reconstructed meanings	positive	12	8		Fisher's exact	1		1	23	
								yes			negative	2	1							
RQ2b	5.3.2	x	no successful reconstruction of an intended meaning	w_P2P			self-referential meaning statement	no	(<->)	Valence of reconstructed meanings	positive	15	1		Fisher's exact	0.03325		1	45	0.343
								yes			negative	18	11							
RQ2b	5.3.2	yes	no successful reconstruction of an intended meaning	only self-referential meaning statement	MeMa O:service		service examples	all others	(->)	Valence of reconstructed meanings	positive	9	0		Fisher's exact	0.00226		1	18	0.798
								w_P2P			negative	2	7							
	5.3.2	x		b_PSS				yes	(<->)		positive	6	9			0.04409		2	28	0.486

RQ of ES	Section	all covered services	condition 1	condition 2	condition 3	condition 4	independent variable	and its values (top cell: 1st value)	(assumed) direction of influence (x: no correl.)	target (contingent) variable	and its values	Number of occurrences columns: moderating variable (left: 1st value)			applied stat. test	p	value	df	N	Cramer's V
RQ2b			no successful reconstruction of an intended meaning				self-referential meaning statement	no		Valence of reconstructed meanings	neutral or ambivalent	0	4		Freeman-Halton test					
											negative	0	9							
RQ2b	5.3.2	yes	no successful reconstruction of an intended meaning	only self-referential meaning statement	MeMa C:people		service examples	b_PSS	(->)	Valence of reconstructed meanings	positive	5	3		Fisher's exact	0.00275		1	21	0.713
								all others			negative	0	13							
RQ2b	5.3.3		no successful reconstruction of an intended meaning	made by non-user			way of inquiry	observing	x	Valence of reconstructed meanings	positive	42	23		chi²	0.366241	0.8	1	146	
								anticipating			negative	58	23							
RQ2b	5.3.3		no successful reconstruction of an intended meaning	made by non-user	w_P2P		way of inquiry	observing	(->)	Valence of reconstructed meanings	positive	6	9		Fisher's exact	0.01255		1	44	0.407
								anticipating			negative	2	27							
RQ2b	5.3.3		no successful reconstruction of an intended meaning	made by non-user	all covered services!	MeMa lvl1 C:processes	way of inquiry	observing	(->)	Valence of reconstructed meanings	positive	8	9		Freeman-Halton test	0.02873		2	43	0.398
											neutral or ambivalent	5	4							
								anticipating			negative	2	15							
RQ2b	5.3.3		no successful reconstruction of an intended meaning	made by non-user			service examples	b_PSS	(<->)	way of inquiry	observing	30	134		chi²	1.61E-10	40.9	1	474	0.294
								all others			anticipating	6	304							
RQ2b	5.3.4		no successful reconstruction of an intended meaning				reconstr M's basis of rela. betw. S & C	causality	x	Valence of reconstructed meanings	positive	48	32		chi²	0.068768	3.3	1	161	
								convention			negative	37	44							

RQ of ES	Section	all covered services	condition 1	condition 2	condition 3	condition 4	independent variable	and its values (top cell: 1st value)	(assumed) direction of influence (x: no correl.)	target (contingent) variable	and its values	Number of occurrences columns: moderating variable (left: 1st value)			applied stat. test	p	value	df	N	Cramer's V
RQ2b	5.3.4	x	no successful reconstruction of an intended meaning	w_PSS			reconstr M's basis of rela. betw. S & C	causality	(<->)	Valence of reconstructed meanings	positive	11	3		Fisher's exact	0.04901		1	39	0.334
								convention			negative	11	14							
RQ2b	5.3.4	yes	no successful reconstruction of an intended meaning	all covered services!	MeMa lvl1 C:people		reconstr M's basis of rela. betw. S & C	causality	(<->)	Valence of reconstructed meanings	positive	23	16		chi²	0.031844	4.6	1	84	0.234
								convention			negative	16	29							
RQ2b	5.3.4		no successful reconstruction of an intended meaning	all covered services!	MeMa lvl3 C:user		reconstr M's basis of rela. betw. S & C	causality	(<->)	Valence of reconstructed meanings	positive	21	13		chi²	0.024842	5.0	1	71	0.266
								convention			negative	13	24							
RQ3	5.5.1						Valence of reconstructed meanings	positive	(<->)	use	user	114	3		chi²	7.52E-07	24.5	1	474	0.227
								negative			non-user	276	81							
RQ3	5.5.1						Valence of reconstructed meanings	positive	(<->)	use	user	114	12	3	chi²	2.24E-07	30.6221	2	561	0.234
								neutral or ambivalent			non-user	276	75	81						
								negative												
RQ3	5.5.1		reconstr M: S-C: causal				Valence of reconstructed meanings	positive	(<->)	use	user	68	1		chi²	0.001024	10.8	1	284	0.195
								negative			non-user	179	36							
RQ3	5.5.1		reconstr M: S-C: convent				Valence of reconstructed meanings	positive	(<->)	use	user	45	2		chi²	0.00015	14.4	1	178	0.284
								negative			non-user	89	42							
RQ3	5.5.1	x	b_PSS				Valence of reconstructed meanings	positive	(<->)	use	user	62	1		Fisher's exact	0.00016		1	89	0.440
								negative			non-user	18	8							

RQ of ES	Section	all covered services	condition 1	condition 2	condition 3	condition 4	independent variable	and its values (top cell: 1st value)	(assumed) direction of influence (x: no correl.)	target (contingent) variable	and its values	Number of occurrences columns: moderating variable (left: 1st value)			applied stat. test	p	value	df	N	Cramer's V
RQ3	5.5.1	x	b_P2P				Valence of reconstructed meanings	positive	x	use	user	19	2		Fisher's exact	0.67852		1	75	
								negative			non-user	48	6							
RQ3	5.5.1	x	w_MS				Valence of reconstructed meanings	positive	x	use	user	20	0		Fisher's exact	0.06041		1	86	
								negative			non-user	54	12							
RQ3	5.5.1	x	b_PSS	no successful reconstruction of an intended meaning			Valence of reconstructed meanings	positive	(<->)	use	user	13	1		Fisher's exact	0.00049		1	24	0.742
								negative			non-user	2	7							
RQ3	5.5.1	yes	MeMa O:service				Valence of reconstructed meanings	positive	(<->)	use	user	56	1		chi²	0.001693	9.9	1	229	0.207
								negative			non-user	140	32							
RQ3	5.5.1		MeMa C:people				Valence of reconstructed meanings	positive	(<->)	use	user	62	0		chi²	5.95E-06	20.5	1	231	0.298
								negative			non-user	124	45							
RQ3	5.5.1		no successful reconstruction of an intended meaning	MeMa O:service			Valence of reconstructed meanings	positive	(<->)	use	user	8	1		Fisher's exact	0.03508		1	73	0.257
								negative			non-user	32	32							
RQ3	5.5.1		no successful reconstruction of an intended meaning	MeMa C:people			Valence of reconstructed meanings	positive	(<->)	use	user	13	0		chi²	4.13E-05	16.8	1	86	0.442
								negative			non-user	28	45							
RQ3	5.5.1	x	b_PSS	MeMa O:service			Valence of reconstructed meanings	positive	(<->)	use	user	29	0		Fisher's exact	0.00639		1	42	0.485
								negative			non-user	9	4							
RQ3	5.5.1	x	b_PSS	MeMa C:people			Valence of reconstructed meanings	positive	(<->)	use	user	33	0		Fisher's exact	0.00028		1	47	0.587
								negative			non-user	8	6							
RQ3	5.5.1	x	b_PSS	MeMa S:tech.sys			Valence of reconstructed meanings	positive	(<->)	use	user	8	0		Fisher's exact	0.01282		1	18	0.632
								negative			non-user	4	6							

RQ of ES	Section	all covered services	condition 1	condition 2	condition 3	condition 4	independent variable	and its values (top cell: 1st value)	(assumed) direction of influence (x: no correl.)	target (contingent) variable	and its values	Number of occurrences columns: moderating variable (left: 1st value)			applied stat. test	p	value	df	N	Cramer's V
RQ3	5.5.2	yes					self-referential meaning statement	yes	(<->)	use	user	33	96		chi²	8.42E-05	15.5	1	561	0.166
								no			non-user	50	382							
RQ3	5.5.2		reconstr M: S-C: causal				self-referential meaning statement	yes	(<->)	use	user	68	1		chi²	0.002482	9.2	1	321	0.169
								no			non-user	179	36							
RQ3	5.5.2		reconstr M: S-C: convent				self-referential meaning statement	yes	(<->)	use	user	45	2		chi²	0.016783	5.7	1	217	0.162
								no			non-user	89	42							
RQ3	5.5.2		successful reconstruction of an intended meaning				self-referential meaning statement	yes	(<->)	use	user	22	80		chi²	0.000961	10.9	1	344	0.178
								no			non-user	21	221							
RQ3	5.5.2		no successful reconstruction of an intended meaning				self-referential meaning statement	yes	(<->)	use	user	11	29		Fisher's exact	0.0032		1	217	0.217
								no			non-user	16	161							
RQ3	5.5.2		no successful reconstruction of an intended meaning	positive valence			self-referential meaning statement	yes	(<->)	use	user	8	12		Fisher's exact	0.00574		1	85	0.325
								no			non-user	7	58							
RQ3	5.5.2		no successful reconstruction of an intended meaning	negative valence			self-referential meaning statement	yes	x	use	user	1	2		Fisher's exact	0.56274		1	84	
								no			non-user	19	62							
RQ3	5.5.2	x	successful reconstruction of an intended meaning	b_PSS	M5: 10 out of 11		self-referential meaning statement	yes	(<->)	use	user	11	39		Fisher's exact	0.02675		1	70	0.273
								no			non-user	0	20							
RQ3	5.5.2	x		b_P2P				yes	x	use	user	5	17			0.47267		1	61	

RQ of ES	Section	all covered services	condition 1	condition 2	condition 3	condition 4	independent variable	and its values (top cell: 1st value)	(assumed) direction of influence (x: no correl.)	target (contingent) variable	and its values	Number of occurrences columns: moderating variable (left: 1st value)			applied stat. test	p	value	df	N	Cramer's V
			successful reconstruction of an intended meaning				self-referential meaning statement	no			non-user	5	34		Fisher's exact					
RQ3	5.5.2	x	successful reconstruction of an intended meaning	w_MS			self-referential meaning statement	yes	x	use	user	2	16		Fisher's exact	1		1	61	
								no			non-user	4	39							
RQ3	5.5.2	x	no successful reconstruction of an intended meaning	b_PSS			self-referential meaning statement	yes	(<->)	use	user	6	8		Fisher's exact	0.01594		1	28	0.522
								no			non-user	0	14							
RQ3	5.5.2	yes					comparison to competitors/alternatives	yes	(->)	self-referential meaning statement	yes	23	91		chi²	0.031071	4.6	1	733	0.080
								no			no	78	541							
RQ3	5.5.2		only self-referential meaning statement				comparison to competitors/alternatives	yes	(->)	Valence of reconstructed meanings	positive	19	43		chi²	0.043586	4.1	1	106	0.196
								no			negative	1	21							
RQ3	5.5.2		no self-referential meaning statement				comparison to competitors/alternatives	yes	x	Valence of reconstructed meanings	positive	56	302		chi²	0.296604	1.1	1	518	
								no			negative	7	63							

Appendix D: Overview of qualitative results

RQ of ES	*Section*	*service example*	*meaning by*	*general theme*
RQ2a	5.2.8.1	b_MS	designer (M2)	mostly successfully conveyed
RQ2a	5.2.8.1	w_MS	designer (M4)	
RQ2a	5.2.8.1	b_PSS	designer (M5)	
RQ2a	5.2.8.2	w_MS	designer (M1)	mostly unsuccessfully conveyed
RQ2a	5.2.8.2	w_PSS	designer (M2)	
RQ2a	5.2.8.2	w_PSS	designer (M1)	
RQ2a	5.2.8.2	w_PSS	designer (M8)	
RQ2a	5.2.8.3	b_P2P	designer (M4)	controversial intended meanings
RQ2a	5.2.8.3	w_P2P	designer (M1)	
RQ2a	5.2.8.3	w_PSS	designer (M3&4)	
RQ2a	5.2.8.4	b_P2P	designer (M5)	rarely addressed intended meanings
RQ2a	5.2.8.4	b_P2P	designer (M3)	how service was provided -> implication for design
RQ2a	5.2.8.4	b_P2P	designer (M15)	rarely addressed intended meanings
RQ2a	5.2.8.4	w_MS	designer (M2)	
RQ2a	5.2.8.5	w_MS	designer (M3)	other abnormalities
RQ2a	5.2.8.5	b_PSS	designer (M3)	
RQ2a	5.2.8.5	w_P2P	designer (M7)	
RQ2b	5.3.5.1	b_PSS	non-users	how service was provided -> implication for design
RQ2b	5.3.5.1	b_PSS	a user	
RQ2b	5.3.5.2	b_P2P	non-users	Preconceptions
RQ2b	5.3.5.3	w_PSS	non-users	Concerns for others
RQ2b	5.3.5.4	w_P2P	non-users	Negative side effect
RQ2b	5.3.5.5	w_MS	non-users	Unintended consequences
RQ2b	5.3.5.6	w_MS	non-users	Trade-offs in design
RQ2c	5.4.1	w_MS	a user	implicit assumptions behind intended meanings
RQ2c	5.4.2	w_P2P	non-users	Positive side effect

RQ of ES	*Section*	*service example*	*meaning by*	*general theme*
		b_MS	non-users	
RQ2c	5.4.3	b_P2P	non-users	Unintended target group
RQ2c	5.4.4	b_PSS	a user	Powerful concepts
RQ2c	5.4.5	w_PSS	non-users	service symbolizing (standing for) users
		b_MS	non-users	
RQ3	5.5.3.1	any	users and non-users	most often applied M-B mechanisms
RQ3	5.5.3.2	any	to past: mainly non-user adap att: user	least often applied M-B mechanisms
RQ3	5.5.3.3	b_P2P, b_PSS	users	negative personal meanings
RQ3	5.5.3.4	b_PSS	a user	mutual influence betw M&B
RQ3	5.5.3.5	any	users and non-users	similarities between users and non-users
RQ3	5.5.3.6	b_P2P	user and non-user	expectations
RQ3	5.5.3.7	w_MS, w_P2P	non-users	intrapersonal conflicts
RQ3	5.5.3.8	any	users and non-users	M-B mechanisms in MeMa
RQ3	5.5.3.9	any	users and non-users	thoughts by others
RQ3	5.5.4	b_PSS, b_MS	designers, users and non-users	explicitly stating intention to change behavior
RQ3	5.5.4	b_PSS	users	concepts for behavioral change
RQ3	5.5.4	any	designers, users and non-users	explicitly stating sustainability