An Exploration of Smart Product-Service System Design
Guidelines and Insights for Design Management

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DOI
10.4233/uuid:a78ba8b6-b865-4408-9788-468e635fa39b

Publication date
2017

Document Version
Final published version

Citation (APA)
Valencia Cardona, A. (2017). *An Exploration of Smart Product-Service System Design: Guidelines and Insights for Design Management*. [Dissertation (TU Delft), Delft University of Technology]. https://doi.org/10.4233/uuid:a78ba8b6-b865-4408-9788-468e635fa39b

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SMART
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DESIGN

Guidelines and Insights for Design Management

Ana Valencia

AN EXPLORATION OF SMART PRODUCT-SERVICE SYSTEM DESIGN

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ISBN 978-94-6186-795-7

Printed in The Netherlands by Ipskamp Printing.
Cover design: Ana Valencia
Book design: Ana Valencia
Circular element in cover and throughout thesis: Starline (Freepik.com)

AN EXPLORATION OF SMART PRODUCT-SERVICE SYSTEM DESIGN

Guidelines and Insights for Design Management

Proefschrift

ter verkrijging van de graad van doctor
aan de Technische Universiteit Delft,
op gezag van de Rector Magnificus Prof. Ir. K.C.A.M. Luyben,
voorzitter van het College voor Promoties,
in het openbaar te verdedigen op
dinsdag 4 april 2017 om 12:30 uur

Door

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This thesis was funded by the Dutch Ministry of Education, Culture and Science as part of the Creative Industry Scientific Program (CRISP).

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Summary

This thesis reports on the findings of a research project funded by the Dutch Ministry of Education, Culture and Science. The thesis investigates the ***design of Smart Product-Service Systems (Smart PSSs)***, defined as the integration of smart, connected products and e-services, presented to consumers as single solutions to satisfy their needs. Smart PSSs are relatively new value propositions that have been well received by consumers. The number of Smart PSSs in the marketplace has risen in the past years, and their presence is forecasted to grow significantly in the years to come. However, their newness in the market implies that companies are still adapting to their design and implementation. Various reports from practice suggest important ambivalences of these solutions with important negative effects on the experiences and value consumers attach to Smart PSSs.

Consequently, the aim of this thesis is to provide designers and design managers with guidelines and insights, which can aid the design and implementation of Smart Product-Service Systems (Smart PSSs) with increased and lasting value for companies and consumers. This information is of relevance for designers because the role that they play in the development of Smart PSSs is likely to increase, just as the presence of these offerings in the market continues to grow. Designers ought to be well prepared for such relatively new design scenarios. It is of great importance that designers understand the particularities of Smart PSSs design, its opportunities and challenges, and the likely contribution of their activities to the development of meaningful value propositions. By doing so designers can contribute to the efficient development of Smart PSSs, and the design of value propositions that are cherished by consumers over time.

Consequently, to achieve our research aim, two particular perspectives were followed. First, we investigated the *aspects influencing the design and definition of Smart PSSs during the development phase*. Regarding this perspective, two topics were addressed: the 'characteristics of Smart PSSs', and 'the Smart PSS design process'. These topics were further translated into two specific research questions: ***What set of design characteristics can designers use while defining Smart PSS value propositions?*** And, ***How can designers support the design process of Smart PSSs?*** The second defined perspective is the *effect of design decisions on consumers' experiences with Smart PSSs*. Concerning this perspective, one topic and one research question were addressed. The topic was defined as 'consumers' reactions to Smart PSSs', and the research question stated as follows: ***How can designers trigger positive consumer responses with Smart PSSs?***

The thesis follows a multidisciplinary research approach, building from theories

of different fields, such as operations management, design management, service design, and traditional PSS design. Furthermore, the three research questions outlined above were investigated by means of four qualitative and one quantitative studies, reported in the empirical chapters Chapter 3, Chapter 4, and Chapter 5.

Chapter 3 focuses on the first research question: *What set of design characteristics can designers use while defining Smart PSS value propositions?* The research question was investigated by means of two qualitative studies: **Study #1-a** and **Study #1-b**. Seven characteristics of Smart PSSs were identified: *1) consumer empowerment, 2) individualization of services, 3) community feeling, 4) individual/shared experience, 5) product ownership, 6) service involvement*, and 7) *continuous growth*. These characteristics can be shaped in various ways, through various features. Importantly, the characteristics of Smart PSSs can be used when defining Smart PSSs at different levels of abstraction, and for different goals during the design process. For example, to define the specifics of individual elements in the system (e.g., features in the e-service), or during co-creation sessions among stakeholders on strategic aspects that can influence the system and its implementation.

Chapter 4 addressed the second research question: *How can designers support the design process of Smart PSSs?* Three sub-questions were further defined, which guided our research efforts. All these sub-questions were investigated by means of a qualitative approach reported as **Study #2**.

The first sub-question was the following: What are the elements of the Smart PSS design process? In this regard, we found the design process of Smart PSSs to have much in common with that of traditional PSSs, but also to display distinct differences. In terms of similarities, Smart PSS design can be described as involving a *large number of stakeholders* with varying needs and goals towards value propositions. Smart PSSs, too, are highly *context dependent*, where context helps to define the value propositions for different users. In terms of differences, Smart PSS design provides designers with *broadened design options* on how to define and implement the Smart PSS value proposition due to its multi-touchpoint nature. Furthermore, Smart PSSs are *ever-growing, ever-evolving*, and this dynamism is translated into a design process that is ongoing.

The second sub-question was stated as follows: What are the challenges of Smart PSS design? In this regards, we found the elements of Smart PSS design to lead to seven challenges of Smart PSS design: *1) defining the value proposition, 2) maintaining the value proposition over time, 3) creating high-quality interactions, 4) creating coherence in the Smart PSS, 5) stakeholder management, 6) the clear communication of design goals,* and 7) *the selection of means and tools in the design process.* Importantly, these challenges are rooted in one or more elements of Smart PSS design outlined above. However, we found the broadened design options of Smart PSS design, and the ever-growing nature of Smart PSSs, to be particularly distinct of this development context, and to create a complexity in the design process that can be

overwhelming for designers.

The third and last sub-question reported in Chapter 4 was the following: What are the designer role/contributions that help tackle design challenges? Our findings point to five roles/contributions that are being used by designers to tackle design challenges while supporting the Smart PSS design process. Namely, designers were described as: *1) guardians of user experiences, 2) foreseers of future scenarios, 3) integrators of stakeholders needs, 4) problem solvers,* and *5) visualizers of goals*. We found the identified roles/contributions to belong to the set of design skills long discussed by the design community, and to be effective in dealing with the above challenges. Based on these insights, we conclude that the current skills set of designers contributes to dealing with the complexity of the Smart PSS design process. However, designers should be made aware of the distinct elements of Smart PSS design and the design challenges likely to be encountered, so that they can be better prepared and use their skills more effectively.

Chapter 5 reports on the third research question investigated in the research project: *How can designers trigger positive consumer responses with Smart PSSs?* This question was investigated by means of two distinct studies, namely, **Study #3** and **Study #4**.

The aim of Study #3 was to address the following sub-question: What is the effect of coherence between products and service elements on consumers' evaluations of Smart PSSs? To this end, an experimental study with consumers was conducted. The effect of coherence was studied by manipulating the symbolic meaning 'professionalism' of a product and service elements of a fictional rental car solution. Importantly, potential incoherencies between product and service elements were anticipated to look unreliable in the eyes of consumers and negatively affected their evaluations of the Smart PSS. Our results validate this assumption and indicate that consumers value the coherence in Smart PSSs. By creating coherence between the elements of the Smart PSS, designers can help evoke assurance with consumers, which results in a more positive evaluation of the overall offering.

The aim of Study #4 was to address the following two sub-questions: 1) How do consumers' experiences with Smart PSSs develop over time, and 2) What factors should designers consider when defining user experiences with Smart PSSs? To answer these sub-questions, a longitudinal, qualitative research approach was followed. Overall, users' experiences with Smart PSSs were found to be complex and cyclic. The multi-touchpoint nature of Smart PSSs was found to be a pressing element on how users' experiences develop. The variety of elements in the system can complicate the understanding of the value proposition of each touchpoint, but also of the Smart PSS as a whole. Furthermore, users' experiences are cyclic because Smart PSSs offer users the unique possibility to renew their value propositions over time, by means of new elements in the system, features, and content. However, every time the system changes, and users implement changes in their value propositions,

they enter an orientation cycle that is influential of their continued engagement with the Smart PSS.

Finally, we identified four main factors that affect the transition from orientation to incorporation in users' experiences with Smart PSSs: 1) *quality of information*, 2) *number of options in the system*, 3) *coherence of functionality*, and 4) *product attributes*. Several features in the Smart PSSs can influence these factors. For example, accuracy of data, and the format in which information is presented, are different features that can influence the quality of information in the system. Furthermore, identified factors and features have been associated with different steps in the temporality of users' experiences with Smart PSSs.

Overall, it can be concluded that Smart PSSs are complex solutions, for designers and consumers alike. The design of Smart PSSs poses several important challenges, outlined through the several empirical studies reported in this thesis. Challenges are rooted in several elements of the Smart PSS design process, and of these, there are two that particularly pronounced design complexities: the *multi-touchpoint*, and the *ever-growing, ever-evolving* nature of Smart PSSs. For designers, these elements complicate the definition of the value proposition during the design process. For consumers, they complicate the understanding of the Smart PSS and their interaction with it. Importantly, designers can play important roles and make important contributions to the design process, which tackle specific design challenges and aid in the development of meaningful Smart PSSs value propositions to consumers.

In terms of the relevance of our research, Chapter 7 discusses the theoretical contribution and practical implications of our findings. Particularly, research findings are translated into ten design guidelines (practical Do's and Don'ts) for Smart PSS design. In line with the two perspectives followed in this thesis, these guidelines point to two district areas where designers' roles/contributions gain relevance: the efficacy of the design process, and the creation of meaningful value propositions. Such information is relevant because it can help designers to gauge the need to adapt their best practices (i.e., tools, skills) to the design of Smart PSSs. Furthermore, the guidelines and insight presented in Chapter 7 can help designers to manage and maximize the experience of users, and trigger positive responses, at specific stages of the user experience.

Samenvatting

Dit proefschrift beschrijft de resultaten van een onderzoeksproject gefinancierd door het ministerie van Onderwijs, Cultuur en Wetenschap (OCW). Het proefschrift onderzoekt het ***ontwerp van Smart Product-Service Systems (Smart PSSs).*** 'Smart PSSs' (ofwel Slimme Product-Dienst Systemen) zijn combinaties van digitale of verbonden producten en elektronische diensten die in één oplossing zijn geïntegreerd, welke als geheel voldoet aan de behoeftes van consumenten. Zulke 'Smart PSSs' zijn goed zijn ontvangen op de markt, ondanks dat dergelijke combinaties van producten en diensten relatief nieuw zijn voor consumenten. De afgelopen jaren is het aantal op de markt beschikbare 'Smart PSSs' gestegen en de verwachting is dat de komende jaren meer van dit soort oplossingen zullen worden geïntroduceerd. Echter, het feit dat 'Smart PSSs' zo nieuw zijn betekend dat organisaties nog bezig zijn met het aanpassen van hun ontwerp en realisatieprocessen aan dit soort oplossingen. Meerdere praktijkgerichte studies geven bijvoorbeeld aan dat 'Smart PSSs' omgeven zijn met onzekerheid, wat een negatieve impact kan hebben op de ervaring en de waarde die consumenten aan deze oplossingen toekennen.

Het doel van dit proefschrift is daarom om ontwerpers en hun managers te verschaffen met richtlijnen en inzichten die kunnen helpen bij het ontwerpen en implementeren van 'Smart PSSs' die op de lange termijn waardevol zijn voor zowel consumenten als organisaties. Deze informatie is relevant voor ontwerpers omdat de rol die zij spelen in het ontwerpen van 'Smart PSSs' waarschijnlijk groter zal zijn in de toekomst, net zoals de aanwezigheid van dit soort oplossingen op de markt groeiende is. Ontwerpers zouden goed voorbereid moeten zijn op het tackelen van deze relatief nieuwe ontwerpuitdagingen. Het is van groot belang dat ontwerpers de eigenaardigheden van het ontwerpen van 'Smart PSSs' begrijpen, evenals de kansen en uitdagingen ervan, en dat ze hun mogelijke bijdrage aan de ontwikkeling van betekenisvolle waarde proposities van 'Smart PSSs' begrijpen. Door dit te doen kunnen ontwerpers bijdragen aan de efficiënte ontwikkeling van 'Smart PSSs, en aan het creëren van waarde proposities die consumenten koesteren over tijd.

Om het onderzoeksdoel te behalen werden twee specifieke perspectieven geadresseerd. Allereerst onderzocht dit proefschrift de *aspecten die het ontwerp en de definitie van 'Smart PSSs' gedurende de ontwikkelingsfase bepalen*. Als onderdeel van dit perspectief werden twee onderwerpen behandeld, namelijk: *De eigenschappen van 'Smart PSSs'* en *Het 'Smart PSSs' ontwerpproces*. Deze onderwerpen werden verder vertaald in twee onderzoeksvragen: ***Welke set van eigenschappen kunnen ontwerpers gebruiken tijdens het definiëren van de waarde propositie van 'Smart PSSs'?*** en ***Hoe kunnen ontwerpers het ontwerpen van 'Smart PSSs'***

ondersteunen? Het tweede perspectief betreft het *effect van ontwerpbeslissingen op de consumenten ervaringen van 'Smart PSSs'*. Dit perspectief werd vertaald in één onderwerp en één onderzoeksvraag. Het onderwerp werd gedefinieerd als *De consumenten reacties op 'Smart PSSs''*, en de onderzoeksvraag werd als volgt geformuleerd: ***Hoe kunnen ontwerpers positieve consumenten reacties uitlokken met 'Smart PSSs'?***

Dit proefschrift volgt een multidisciplinaire onderzoeks-aanpak, voortbouwende op theorieën uit verschillende velden zoals operationeel management, ontwerp management, de ontwikkeling van diensten, en de traditionele ontwikkeling van product-dienst systemen. Verder werden de drie onderzoeksvragen die hierboven zijn beschreven onderzocht door middel van vier kwalitatieve studies en één kwantitatieve, welke beschreven staan in de empirische Hoofdstukken 3, 4 en 5.

Hoofdstuk 3 zoekt een antwoord op de eerste onderzoeksvraag, namelijk: Welke set van eigenschappen kunnen ontwerpers gebruiken bij het definiëren van de waarde propositie van 'Smart PSSs'. Deze onderzoeksvraag werd behandeld in twee kwalitatieve studies: **Studie #1-a** en **Studie #1-b**. Middels deze studies werden zeven eigenschappen van 'Smart PSSs' geïdentificeerd, namelijk: *1) mondigheid van de consument, 2) individualisering van diensten, 3) gemeenschapsgevoel, 4) individuele/gedeelde ervaring, 5) product eigendom, 6) betrokkenheid in de diensten, en 7) langdurige groei*. Deze eigenschappen van 'Smart PSSs' kunnen op verschillende manieren worden vormgegeven, middels de verschillende functionaliteiten van dit soort oplossingen. Belangrijk is dat de eigenschappen van 'Smart PSSs' een rol kunnen spelen tijdens het definiëren van 'Smart PSSs' op verschillende abstractieniveaus, en voor het tastbaar maken van verschillende ontwerpdoelen. Zo kunnen de karakteristieken bijvoorbeeld gebruikt worden om de individuele elementen in het systeem (bijvoorbeeld, de functionaliteiten van de elektronische dienst) te definiëren, of ze kunnen gebruikt worden tijdens co-creatie sessies met belanghebbende partijen om de strategische aspecten die het systeem en zijn implementatie kunnen beïnvloeden te onderzoeken.

Hoofdstuk 4 behandelde de tweede onderzoeksvraag: *Hoe kunnen ontwerpers het ontwerpen van Smart PSSs ondersteunen?* Om deze vraag te beantwoorden werden drie sub-vragen gedefinieerd, welke als leidraad dienden bij het onderzoeksproces. Al deze sub-vragen werden behandeld door middel van een kwalitatieve studie als gerapporteerd in **Studie #2**.

De eerste sub-vraag was: Wat zijn de elementen die het ontwerpproces van Smart PSS beschrijven? Met betrekking tot deze vraag hebben we gevonden dat het ontwerpproces van 'Smart PSS' veel overeenkomsten heeft met het ontwerpproces van traditionele PSSs, maar dat er ook verschillen zijn. Er zijn bijvoorbeeld *vele belanghebbende partijen* betrokken bij het ontwerpen van 'Smart PSS', en al deze partijen hebben hun eigen verschillende behoeftes en doelen met betrekking tot de waarde propositie van zulke oplossingen. Ook zijn 'Smart PSSs' *context afhankeli-*

jk, aangezien de context helpt om de waarde propositie voor verschillende gebruikers te bepalen. Tijdens het ontwerpen van 'Smart PSSs' hebben ontwerpers ook *uitgebreidere ontwerp-opties* met betrekking tot het definiëren en implementeren van de waarde propositie, wat komt doordat 'Smart PSSs' vele contactpunten met de consument hebben. Als laatste kunnen 'Smart PSSs' gekarakteriseerd worden als oplossingen die *door groeien en zich door ontwikkelen*, en deze eigenschap vertaalt zich in een ontwerpproces welk continue voortduurt.

De tweede sub-vraag was: Wat zijn de uitdagingen van het ontwerpen van Smart PSS? Als antwoord op deze vraag hebben we gevonden dat de elementen van Smart PSSs leiden tot zeven uitdagingen: *1) het definiëren van de waarde propositie, 2) het constant houden van de waarde propositie over tijd, 3) het creëren van hoogwaardige interacties, 4) het creëren van coherentie in de 'Smart PSS', 5) het managen van de belanghebbende partijen, 6) het duidelijk communiceren van ontwerpdoelen,* en *7) het selecteren van middelen en handvatten tijdens het ontwerpproces*. Deze uitdagingen zijn geworteld in één of meerdere elementen van het ontwerpen van 'Smart PSSs' zoals hierboven beschreven. We hebben echter gevonden dat de uitgebreidere ontwerp-opties van 'Smart PSSs' en de neiging van 'Smart PSSs' om door te groeien en zich door te ontwikkelen specifiek is voor deze context, wat een complexiteit met zich mee kan brengen die overweldigend kan zijn voor ontwerpers.

De derde en laatste sub-vraag werd behandeld door Hoofdstuk 4, en deze vraag was: Wat zijn de rollen of contributies van ontwerpers die helpen bij het tackelen van de ontwerpuitdagingen van Smart PSSs? Onze bevindingen laten zien dat er vijf rollen/contributies zijn die ontwerpers kunnen aannemen bij het tackelen van de ontwerpuitdagingen en bij het ondersteunen van het ontwerpen van 'Smart PSSs'. Ontwerpers werden namelijk beschreven als: *1) bewakers van gebruikerservaringen, 2) voorspellers van toekomstscenario, 3) in staat de behoeftes van belanghebbende partijen te verenigen, 3) probleemoplossers, en 5) in staat doelen te visualiseren.* Eerder onderzoek laat zien dat de geïdentificeerde rollen/contributies behoren bij de set van ontwerpvaardigheden welke al langere tijd worden beschreven door de ontwerpgemeenschap, en welke effectief zijn om de bovenstaande uitdagingen te tackelen. Op basis van deze inzichten hebben we geconcludeerd dat de huidige vaardigheden van ontwerpers hen in staat stellen om om te gaan met de complexiteit van het ontwerpen van 'Smart PSSs'. Echter, ontwerpers moeten gewezen worden op de specifieke eigenschappen van het ontwerpen van 'Smart PSS' en de ontwerpuitdagingen die ze waarschijnlijk zullen tegenkomen, dit zodat ze beter voorbereid zijn en zodat ze hun vaardigheden beter kunnen gebruiken.

Hoofdstuk 5 rapporteert de bevindingen met betrekking tot de derde onderzoeksvraag van dit project: *Hoe kunnen ontwerpers positieve consumenten reacties uitlokken met 'Smart PSSs'?* Deze vraag werd verder onderzocht middels twee studies, namelijk: **Studie #3** en **Studie #4**.

Het doel van Studie #3 was om de volgende sub-vraag te adresseren: Wat is het

effect van coherentie tussen product en dienst elementen op de consumenten evaluatie van Smart PSSs? Om deze vraag te beantwoorden hebben we een experimentele studie met consumenten uitgevoerd. Het effect van coherentie werd bestudeerd door de symbolische waarde "professionaliteit" van de product en dienst elementen van een fictieve huurauto oplossing te manipuleren. We verwachtten dat consumenten potentiele incoherenties tussen product en dienst elementen als onbetrouwbaar zouden beoordelen en dat dit een negatief effect zou hebben op hun evaluaties van 'Smart PSSs'. Onze resultaten valideren deze veronderstelling en laten zien dat consumenten de coherentie in 'Smart PSSs' op waarde schatten. Door coherentie tussen de elementen van 'Smart PSSs' te creëren kunnen ontwerpers zekerheid bij consumenten creëren, wat in een positievere evaluatie van de gehele oplossing resulteert.

Het doel van Studie #4 was om de volgende twee sub-vragen te beantwoorden: 1) Hoe ontwikkelen de ervaringen van consumenten met 'Smart PSS' zich over tijd, en 2) Welke factoren moeten ontwerpers in acht nemen tijdens het definiëren van de gebruikservaringen van 'Smart PSSs'? Om deze vragen te beantwoorden werd een longitudinale, kwalitatieve onderzoek aanpak gevolgd. De resultaten van Studie #4 lieten zien dat de ervaringen van gebruikers met 'Smart PSSs' complex en cyclisch zijn. We hebben gevonden dat de vele contactpunten van 'Smart PSSs' een nadrukkelijk invloed hebben op hoe de ervaringen van gebruikers zich ontwikkelen. De grote hoeveelheid van elementen in een 'Smart PSSs' kan het begrip van de waarde propositie van elk contactpunt en van de 'Smart PSS' als geheel compliceren voor gebruikers. Daarnaast lieten de resultaten zien dat de ervaringen die gebruikers hebben met 'Smart PSSs' cyclisch zijn omdat zulke oplossingen de unieke mogelijkheid geven aan gebruikers om hun waarde propositie over tijd te vernieuwen door middel van nieuwe elementen in het systeem, nieuwe eigenschappen en een nieuwe inhoud. Echter, elke keer dat het systeem veranderd en gebruikers de veranderingen in hun waarde propositie moeten integreren gaan ze een nieuwe cyclus van oriëntatie in, welke van invloed kan zijn op de continuïteit van hun interactie met de 'Smart PSS'.

Als laatste hebben we vier factoren geïdentificeerd die van invloed zijn op gebruikers' transitie van oriëntatie met de 'Smart PSS' naar de integratie van de 'Smart PSS' in hun gebruikservaringen: *1) de kwaliteit van informatie, 2) het aantal opties in het systeem, 3) de coherentie van functionaliteiten,* en *4) product kenmerken*. Een aantal functionaliteiten van de 'Smart PSS' kunnen op invloed zijn op deze factoren. Bijvoorbeeld, de nauwkeurigheid van data en het formaat waarin informatie wordt gepresenteerd zijn functionaliteiten die op invloed kunnen zijn op de kwaliteit van de informatie in het systeem. Verder zijn de geïdentificeerde factoren en functionaliteiten gerelateerd aan de verschillende stappen die gebruikers doorlopen tijdens het opdoen van gebruikservaringen met 'Smart PSSs'.

In het geheel gezien kan er geconcludeerd worden dat 'Smart PSSs' complexe oplossingen zijn, zowel voor ontwerpers als voor consumenten. Het ontwerpen van

'Smart PSSs' heeft een aantal nadrukkelijke uitdagingen, welke we hebben geïdentificeerd in de verschillende empirische hoofdstukken in dit proefschrift. Deze uitdagingen komen voort uit een aantal elementen van het ontwerpproces van 'Smart PSSs', en er zijn twee elementen welke de complexiteit van het ontwerpen zulke oplossingen in het bijzonder weergeven: de *vele contactpunten* die consumenten hebben met 'Smart PSSs', en het *groeiende, ontwikkelende* karakter van 'Smart PSSs'. Voor ontwerpers maken deze elementen het definiëren van de waarde propositie van 'Smart PSSs' moeilijker. Voor consumenten compliceren ze het begrip van 'Smart PSSs' en hun interactie met dit soort oplossingen. Ontwerpers kunnen belangrijke rollen aannemen en belangrijke contributies in het ontwerpproces maken welke specifieke ontwerpuitdagingen tackelen en helpen in het ontwikkelen van waardevolle waarde proposities van 'Smart PSSs' voor consumenten.

De relevantie van ons onderzoek wordt besproken in hoofdstuk 7, waar de theoretische contributie en de praktijk-gerelateerde bijdragen van onze bevindingen worden uitgelijnd. Meer specifiek worden de bevindingen vertaald in tien ontwerprichtlijnen (de *Do's* en *Don'ts*) voor het ontwerpen van 'Smart PSSs'. In lijn met de twee perspectieven die gevolgd zijn in dit proefschrift geven deze richtlijnen twee gebieden aan waar de rollen en contributies van ontwerpers relevant zijn: de doeltreffendheid van het ontwerpproces en het creëren van betekenisvolle waarde proposities. Zulke informatie is relevant omdat het ontwerpers kan helpen om hun huidige werkwijzen (bijvoorbeeld hun tools of vaardigheden) aan te passen aan het ontwerpen van 'Smart PSSs'. Verder kunnen de richtlijnen en inzichten gepresenteerd in Hoofdstuk 7 ontwerpers helpen om de ervaring van gebruikers vorm te geven en te verbeteren, en om positieve reacties uit te lokken in specifieke fases in de gebruikservaring.

Image source: Personal archive

1. Introduction

My sleeping and waking up rituals are very specific these days. The first and last things I do every day is to take my phone, open my ATAG's "One" app, which controls our central heating ATAG thermostat, to make sure the temperature settings are right. Being able to control the temperature remotely has brought various advantages to our lives. For once, we do not have to get out of bed in the cold night when we suddenly realize we have forgotten to lower the temperature. Because the thermostat is connected to the Internet, we can even access the system from everywhere in the world, and make sure we come home to a warm house in the middle of the winter after a holiday.

Like my ATAG thermostat, there are an increasing number of connected products that intend to make the lives of consumers easier. We hear of wearable devices that can track our physical movements and provide us with information via webplatforms (e.g., Fitbit, www.fitbit.com), baby monitors that can be accessed remotely over the phone (e.g., Withings Home, www.withings.com), rental cars that can be booked and tracked online (e.g., Greenwheels, www.greenwheels.com), even Launderettes whose progress in washing our clothes can be followed on the web, so that we only visit them when the washing cycle is ready (e.g., Laundry View, www.laundryview.com). These types of products have something in common. They are composed of smart products (e.g., Rijsdijk & Hultink, 2009) equipped with sensors, microprocessors, and increasingly

with other technologies that allow them to connect to the Internet. Thanks to their embedded technology, these products (also refereed to as the Internet of Things; IoT) are capable of collecting, processing, storing, and communicating information over time.

Statistics on smart/connected products (or IoT) are mind blowing. In 2013, an approximate 3 billion[1] units were reported to be used by both consumers and industry. It is predicted that the number of smart/connected products will continue to rise, reaching between 25 and 50 billion[2] by 2020. Despite the inconclusiveness of forecasted numbers, these projections evidence the expected explosive growth of smart/connected products in the market. Considering the modest projection of 25 billion units would mean a growth of 400% for the period 2013-2020. Furthermore, the same estimates suggest a projected 13,2 billion of smart/connected products for consumer use, driving the total number of units in the market.

The developments above suggest that consumers will increasingly be in touch with smart/connected technologies, everywhere, anywhere. Furthermore, it suggest a scenario where companies progressively take advantage of the possibilities offered by smart/connected products, integrating them with services to reach and interact with consumers in new ways. In fact, many of the existing smart/connected products already have services attached to them. In the case of my ATAG, for instance, it is possible for my service provider to monitor the performance of my boiler remotely. My ATAG "One" collects and stores information on performance and use. When I communicate with my service provider, the app and web platform help as an interface for communication with technicians. Because I can give access to the information collected through my ATAG, they can easily and conveniently diagnose problems and assess the need to visit my home physically.

1.1 Smart Product-Service Systems (Smart PSSs)

In this thesis, we refer to the integration of smart, connected products with e-services, as exemplified above, as Smart Product-Service Systems (Smart PSSs). Smart PSSs are brought to the market as 'solutions' to satisfy the individual needs of consumers. Thus, Smart PSSs are generally composed of several touchpoints, such as products, websites, apps, and service employees. My ATAG (Figure 1.1), for example, is composed of two smart products (thermostat and boiler), several e-services, namely, the ATAG's "One" app and the ATAG's web portal. In addition, my ATAG has been provided to me by a third party, who installed the system, and who provides maintenance whenever needed (i.e., the service).

1 http://www.gartner.com/newsroom/id/290571

2 http://www.cisco.com/c/dam/en_us/about/ac79/docs/innov/IoT_IBSG_0411FINAL.pdf

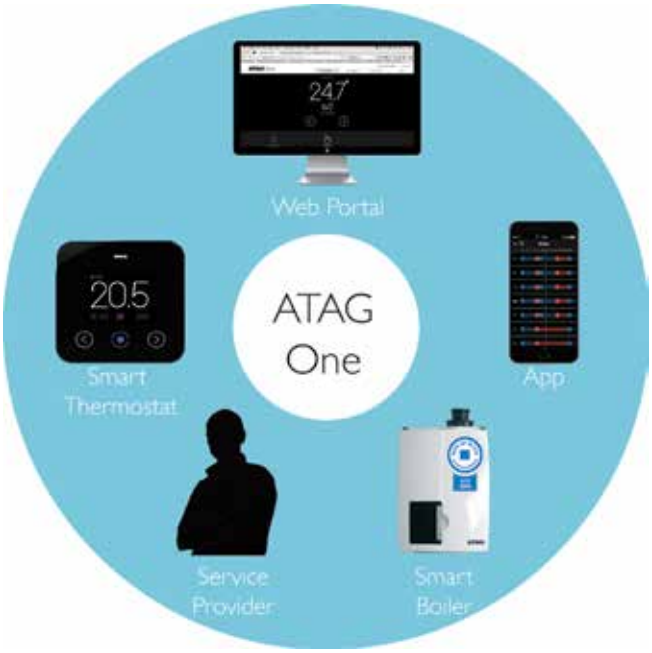

Figure 1.1 ATAG One. This Smart PSS is composed of several touchpoints and smart products, such as an app, a smart thermostat, and employees from the service provider

In contrast to traditional services attached to products (i.e., warranty), the service in the Smart PSS significantly adds *value in use* to the consumer. For example, the design and performance of the ATAG's "One" app has an impact on my perceptions towards the service offered by the company. The application and smart thermostat are the 'interfaces' through which I experience and form my opinion towards the service company (Secomandi & Snelders, 2011). Accuracy in the information measured and provided by the smart products makes me feel secure. When I experience troubles with the boiler, it is essential for my service provider to have access to the same information as me so the technician can tackle issues efficiently. Thus, the different touchpoints in a Smart PSS interact and work as a whole, collectively influencing the experiences and perceptions of consumers.

1.2 Smart PSSs are great… well, almost

Smart PSSs offer great advantages to consumers. However, their newness in the market implies that companies are still adapting to their design and implementation. Companies are still adjusting their business models and operations; adopting

working methods and learning from the market to facilitate the development of Smart PSSs that create value for consumers (Porter & Heppelmann, 2014).

The newness of Smart PSSs implies that consumers may be confronted with interactions and experiences that are far from ideal. For example, while my ATAG has provided me with significant benefits, there are existing pitfalls in its integration, which have caused me (and my family) unforeseen difficulties. Just recently, my husband left for a business trip to China in the middle of the winter. In his absence, our smart thermostat began displaying error codes on its screen. At first, a single touch in the screen made the error warning disappear so I thought it was a simple bug in the system. However, when the warning kept showing up the day after, I knew I needed to do something. My first instinct was to look for relevant information, such as the meaning of the code, or what steps to take, through the app and web platform. But to my surprise, none of this information could be found through the e-services. Wanting to avoid contacting the service (my Dutch is not that good over the phone), I ended up looking for the information online and fixing the problem with the help of my father in law.

But my experience is not an isolated one. User complaints with Google's Nest (another smart thermostat) have been heard on the news after glitches in the system have left users with a cold home in the middle of the winter[3]. In this particular case, the thermostat was unable to connect to the Internet, disconnecting the smart product from the system. The result is a thermostat that cannot be manipulated either manually or through the e-services, leaving users powerless and unable to control the temperature of their home. Another example relates to Fitbit, a smart activity tracker that presents heart beat and other activity information via several e-services. As reported by Fortune[4], several customers presented a joint lawsuit against Fitbit, based on claims that the company misled them in the purchase of their Smart PSSs. Fitbit uses slogans, such as "every bit counts", in their marketing. However, when testing the product after purchase, customers found large inaccuracies in the heart beat information provided through the e-services, compared to other traditional methods. As a result, customers were left with feelings of unreliability towards their devices, especially during high intensity workouts.

The examples above exemplify the different issues users can experience with their Smart PSSs, such as the relevance of accuracy of information and connectivity between different elements in the system. It also exemplifies the effects that poor experiences with Smart PSSs can have over companies. In my personal case, it was the incoherence between what I expected the system to deliver, such as information and interactions, and what was actually provided, which caused me frustration. Once unable to find the information I was after, I was left wondering about the differences

3 http://www.nytimes.com/2016/01/14/fashion/nest-thermostat-glitch-battery-dies-software-freeze.html?_r=4

4 http://fortune.com/2016/01/06/fitbit-heart-rate-accuracy-lawsuit/

between the e-services in the system. How do they differ? What kind of information can I find in each of them? How can I communicate and reach out to my service provider through it? Surprisingly, the answer to the last question is that it is not possible. While the system is designed to support the remote monitoring of issues by my service provider, such communication channels are currently not in place. This limitation undermines the potential of the e-service to support the delivery of services. Furthermore, the questions highlight the need to better understand how aspects of the design and implementation of Smart PSSs influence the experiences and evaluations of consumers.

1.3 Purpose of the thesis

The aim of this thesis is to provide designers and design managers with guidelines and insights, which can aid the design and implementation of Smart Product-Service Systems (Smart PSSs) with increased and lasting value for companies and consumers.

The topic of Smart PSS design has never been of a larger importance to designers. The role that designers play in the development of Smart PSSs is likely to increase, just as the presence of these offerings in the market continues to grow. Thus, designers ought to be well prepared for this relatively new design scenario, learning from its particularities and challenges. It is of great importance that designers understand what the likely contribution of their activities is for companies and consumers.

Accordingly, the thesis follows two particular perspectives relevant to the design management of Smart PSSs. First, the thesis addresses aspects relevant to the activity of designing. Designers can play a pivotal role in the definition of Smart PSSs, such as the characteristics these systems ought to embody to deliver meaningful value propositions. Furthermore, the thesis discusses the Smart PSS design process, providing a better perspective on what designers can encounter once they are involved in such a design activity, and their particular contributions to this process. Second, the thesis addresses the effect that design decisions can have on the experiences of consumers. Addressing the activity of Smart PSS design, as well as its plausible effect on consumers, allow us to provide a more complete view of the Smart PSS design activity, resulting in more comprehensive guidelines for its management.

1.4 Project background

This research is part of the Creative Industry Scientific Program (CRISP), a research initiative sponsored by the Dutch government that ran from 2011 to 2015. The program was set up with the aim of helping the creative industries to attain a more strategic role in the marketplace. CRISP focused on the design of Product-Service Systems (PSSs), which are defined as the combinations of products and services, brought to

the market as one total offering (Goedkoop, van Halen, te Riele, & Rommens, 1999). The program was set up in combination with creative companies, which recognized the emergence of PSSs as a real challenge from practice. Consequently, CRISP aims at developing tools and guidelines for practitioners in the development of these types of offerings, so they can gain a competitive edge in the marketplace.

In CRISP, several research groups were formed, including academic researchers and practitioners, who collaborated doing research on various topics related to PSSs. As such, PSSs were studied from different angles, such as the experience of the user, business feasibility or required technologies. This research was part of the Competitive Advantage through Strategic Design group (CASD). The goal of CASD was to search for ways to implement design thinking ("characterized as a creative, user-centered and vision-based approach, rather than being technology or marketing driven"[5]), as a strategic asset in the design of PSSs. As already stated, the focus of this PhD thesis is on Smart PSS design and the creation of value through meaningful Smart PSS propositions.

The project ran in collaboration with Philips Design (www.design.philips.com) and Fabrique (www.fabrique.nl). Both companies are involved in the design of Smart PSSs for the consumer market. These research partners contributed to this project by giving feedback on the content and focus of the project, and by making resources available, such as material, processes or cases, which are used in the various studies.

1.5 Approach and thesis outline

This thesis is organized as follows (Figure 1.2). First, we provide a theoretical background for the thesis, connected to the perspectives and topics addressed in the thesis. Consequently, Chapter 2 introduces literature relevant to the design of Smart PSS, such as that of PSS development, servitization and service design. Moreover, it presents literature on experience design and consumers' evaluations of products and e-services. Thus, the theoretical background addresses topics relevant to understanding how Smart PSSs are conceived and experienced by users. Furthermore, it highlights the gaps in the existing literature, leading to the identification of questions and sub-questions within each research topic.

Subsequent chapters report on four individual research studies that address our research questions (as identified in Chapter 2). Chapter 3 and Chapter 4 relate to topics relevant to the activity of designing Smart PSSs. Chapter 5 dives into the effect of design decisions on consumers' experiences with Smart PSSs.

Chapter 3 presents two research studies (Study #1-a and Study #1-b), whose

5 http://www.crisprepository.nl/project/casd

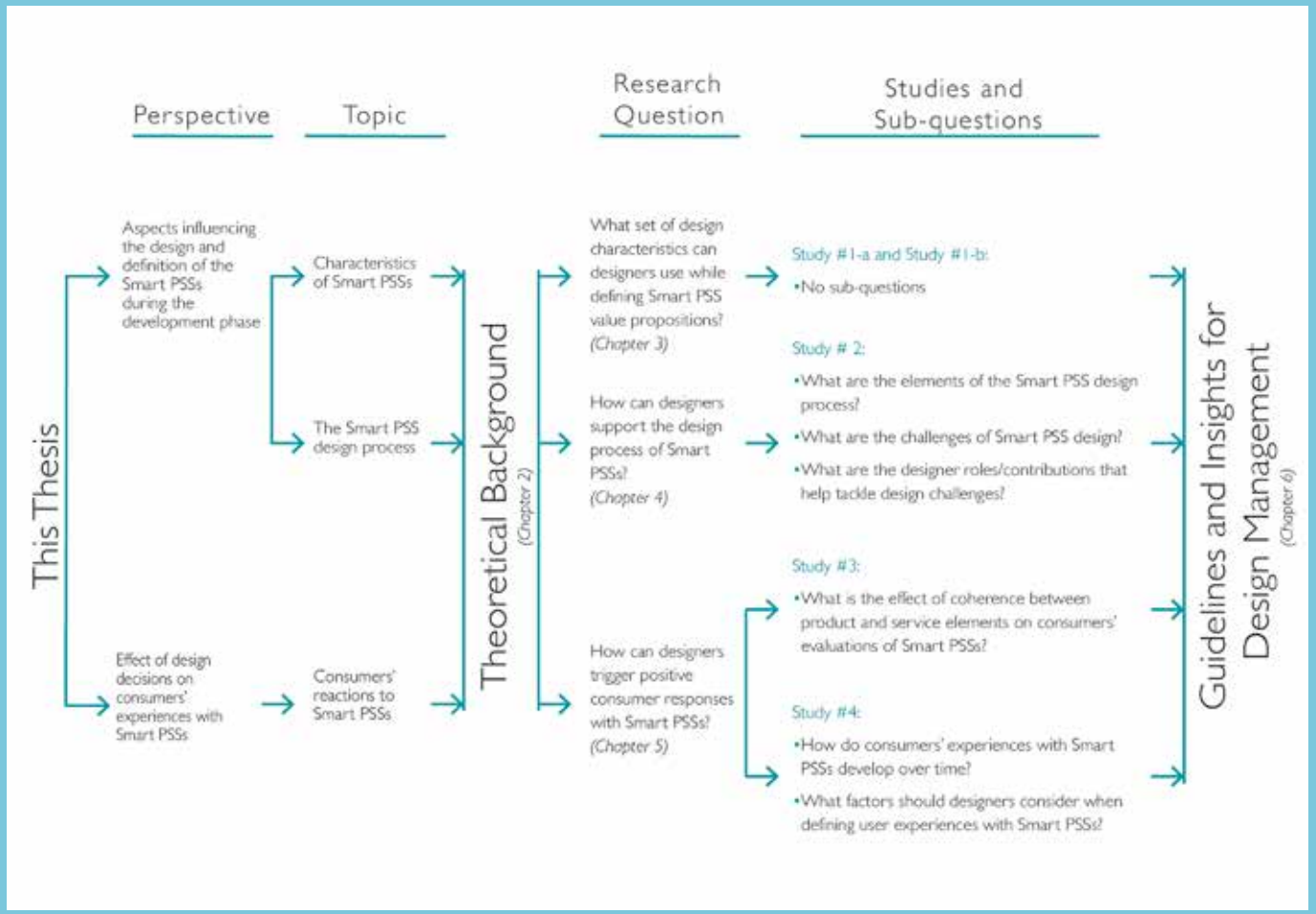

Figure I.2 General outline of the thesis

main research question is formulated as follows: *'What set of characteristics can designers use while defining Smart PSS value propositions?'* To this end, in-depth interviews with designers were conducted, which helped us identify several characteristics of Smart PSSs. Three characteristics stand out. First, through feedback and other relevant information, Smart PSSs empower consumers by enabling them to make decision/take action in their own terms. Second, through the use of digital servicescapes, providers of Smart PSSs are able to individualize their offering (e.g., content, communication) to consumers. Finally, Smart PSSs are in a continuous state of growth, and designers and providers have the opportunity to recurrently update the value proposition to their users.

Chapter 4 dives deeper into the Smart PSS design activity, with the goal of attaining a better understanding of this process and its implications for designers. In particular, the following research question is addressed: *'How can designers support the design process of Smart PSSs?'* This question was investigated by means of a single research study (Study #2), with interviews with experienced designers and discussions of cases as main research method. Furthermore, three particular aspects of the Smart PSS design process (formulated as sub-questions) were researched: 1) What are the elements of the Smart PSS design process? 2) What are the challenges of Smart PSS design? and 3) What are the designer roles/contributions that help tackle design challenges? We identified several elements of Smart PSS design that contribute to specific challenges in the design process. Examples of these elements include the large number of stakeholders, the ever-growing nature of Smart PSSs, and their multi-touch construction. Examples of challenges include the definition of the value proposition to consumers, maintaining the value proposition over time, and the management of stakeholder needs/expectations through the Smart PSS design process. Moreover, we learned about the different skills and toolsets of designers, such as their problem solving and visualizing skills, which contribute to lessen design challenges.

Chapter 5 aims at better understanding consumers' reactions to Smart PSSs. In particular, the chapter addresses the following research question: *'How can designers trigger positive consumer responses with Smart PSSs?'* To this end, two distinct research studies were conducted (Study #3 and Study #4).

The goal of Study #3 was to address the following sub-question: 'What is the effect of coherence between product and service elements on consumers' evaluations of Smart PSSs?' To this end, we explored the effect that (in)coherences within the system can have on consumers' feelings of assurance and attitudes towards a Smart PSS. We focused on achieving coherence through the symbolic meaning that is evoked by both the product and service elements of a Smart PSS. Results of an experimental study suggest that coherent offerings can create assurance with consumers (i.e., reduce the perceived risk), resulting in a more positive evaluation of the complete offering.

Moreover, Study #4 addressed the following two sub-questions: 1) How do consumers' experiences with Smart PSSs develop over time? And 2) What factors should designers consider when defining user experiences with Smart PSSs? These two sub-questions were researched by means of a longitudinal, qualitative research approach. The goal of the study was to better understand how Smart PSS characteristics create value for consumers. The experiences of users while interacting with specific Smart PSSs (i.e., one Smart PSS per participant) in their own environment were documented over a period of eight weeks. Overall, we learned that these types of innovations are difficult to understand by some users. Information is often not presented effectively. Users of Smart PSSs are easily overwhelmed by the large amount of options for individualization. When not designed properly, the biggest strengths of Smart PSSs become the major threats for value creation. When value is not made perceptible from an early stage of the user interaction, users easily interrupt the use of the Smart PSS as they deem it non-convincing.

We conclude the thesis with Chapter 6, which summarizes the insights collected throughout the several studies conducted for this research project. Moreover, the chapter provides an interpretation of the research findings, translating them into relevant guidelines for designers, practical Do's and Don'ts for the design of Smart PSSs. Finally, the chapter provides a discussion on the relevance of our search findings for the existing literature on traditional PSSs, and opportunities for further research.

Image source: https://stocksnap.io (by Ryan McGuire)

2. Theoretical background

In this chapter, we provide an overview of the literature relevant to our study of Smart PSS design and its management. As the goal of this thesis is to provide guidelines and insights for the management of Smart PSS design, it is important to provide a definition for 'design management' that can set the scope for the theoretical background. According to the Design Management Institute[6], design management "encompasses the ongoing processes, business decisions, and strategies that enable innovation and create effectively-designed products, services, communications, environments, and brands that enhance our quality of life and provide organizational success". Thus, design management aims to influence how design is used and organized within organizations, to maximize the value of products and services for companies, consumers, and societies at large.

A key aspect to successful design management is the recognition by companies (and those involved in the management of design) of the benefits that design, or design thinking (Cooper, Junginger, & Lockwood, 2009), can bring to the successful development of products and services (Trueman & Jobber, 1998). Scholars and practitioners have highlighted particular aspects that designers can intervene to maximize value for consumers and organizations (e.g., Brown, 2008; Celaschi, Celi, & García, 2011; Mozota, 2002; Trueman & Jobber, 1998). For example, Trueman and Jobber (1998) identified four design

6 http://www.dmi.org/?What_is_Design_Manag

dimensions where designers can play an active role: value, image, process and production. Design can increase the *value* for consumers of a product/service by defining attributes and characteristics that better answer to their individual needs (Mozota, 2002). Moreover, design can create or improve the *image* of a product/service and company. The interaction of users with products/services influence their experiences and perceptions towards market propositions (Alben, 1997). Thus, value is linked to image in that products/services that answer to the needs of consumers could be perceived as, for example, reliable and of good quality, contributing to the creation of strong brands. Design can influence the development *process* of products/services. Designers can play different roles, for example, as integrators of ideas (Valencia, Person, & Snelders, 2013) or facilitators of discussions (Celaschi et al., 2011), influencing the effectiveness of this process and time to market. Moreover, reports from practice have indicated the evolving role of design thinking within organizations, applied to organizational aspects, such as strategies for business transformation (Cooper et al., 2009). Finally, design can influence how the production of goods is organized, for example, by choosing materials and shapes that reduce costs and production time.

As expressed in Chapter 1, this thesis studies Smart PSS design from two perspectives: aspects influencing the design and definition of the Smart PSSs during the development phase, and the effect of design decisions on consumers' experiences with Smart PSSs. Relating these two perspectives to the aspects of design management presented above, three relevant topics to be discussed in this chapter can be outlined: 1) *The characteristics of Smart PSSs*: in relation to design characteristics that can contribute to the definition of *value* propositions to consumers. 2) *The Smart PSS design process*: in relation to aspects, such as the elements of the Smart PSS design *process* and the roles/contributions of designers, which can influence how the design process unfolds. And, 3) *Consumers' reactions to Smart PSSs*: in relation to how design influences the interactions and experiences of users of Smart PSSs, and the *image* formation of these solutions). Each of these three topics has been further translated into (main) research questions, in relation to designers' participation in the Smart PSS design process:

A. What set of design characteristics can designers use while defining Smart PSS value propositions?

B. How can designers support the design process of Smart PSSs? And,

C. How can designers trigger positive consumer responses with Smart PSSs?

Thus, the purpose throughout the chapter is to shed light into the above questions. The goal is to outline relevant (missing) information for the management of Smart PSS design. Moreover, towards the end of the chapter, appropriate sub-questions for each of the research topics are outlined, highlighting our contribution to the existing literature. To shed light into the above research questions, we review concepts from

different fields, such as traditional PSS design, operations management, design management, service design, and service marketing. We exclude literature related to the production of Smart PSSs (e.g., production techniques engineering design, etc.) as it falls outside the scope of the project.

2.1 What set of design characteristics can designers use while defining Smart PSS value propositions?

To attain a better understanding of how Smart PSSs are characterized, it is important to go back to the roots of the concept. As the project and our conceptualization of Smart PSSs find their origins in the theory on traditional Product-Service Systems (PSSs), we start the chapter with a definition of this concept, discussed benefits and typology. Subsequently, our definition of Smart PSSs and the implications for this research are presented.

2.1.1 Product-Service Systems, what are they?

Product-Service Systems (PSSs) have been defined as market offerings that combine products and services, and present them as single solutions to consumers (Goedkoop et al., 1999). Goedkoop and colleagues define Product-Service Systems as formed by three elements: 1) products; the tangible elements that can vary in the degree of technology they comprise; 2) the service; the activities and actions with an economic value, set in place to enhance the interaction with the product and facilitate the provision of solutions, and 3) the system; defined as the collection of elements, such as infrastructure, people, regulations, organizations, and others, needed to deliver the solution (p. 17)(Figure 2.1).

An example of a PSS is a launderette (i.e., a shared laundry facility, also known as laundromat) (e.g., Mont & Plepys, 2007). This PSS is composed of washing machines (the products) that are made readily available to consumers for self-service purposes (the service), made possible by the cooperation and interaction of different actors and infrastructures, suppliers, information technology (IT) and employees (the system) (Figure 2.2). Benefits of these launderettes for consumers include the avoided cost of purchasing professional machines, but also the access to in-site services, such as the ironing and folding of clothes by the service employees. Launderettes are presented as 'solutions' developed on the basis of both products and services, which are experienced and evaluated as a whole. In assessing their experience with the PSS, consumers will rely on aspects of the product, such as the washing programs available in the device (e.g., delicate/hand wash) and the cleanness of the washing, but also on aspects of the service, such as employee friendliness, general atmosphere in the laundry room, and the quality of the end result (Bitner, 1992).

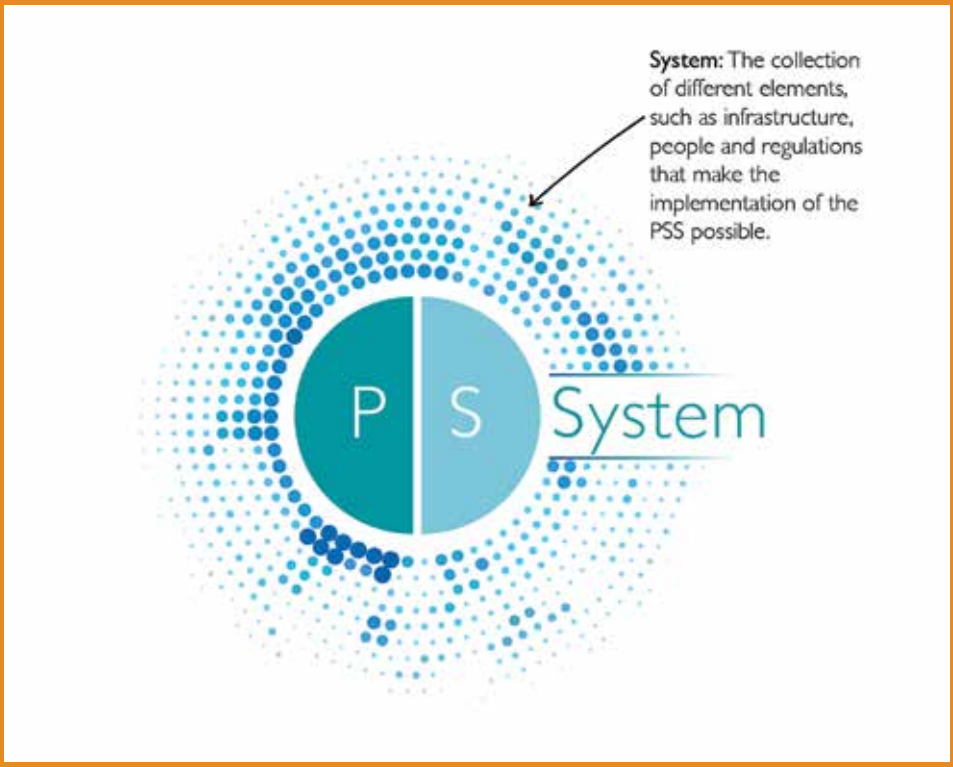

Figure 2.1 Product Service Systems: composed of product(s), service(s) and the system

Figure 2.2 Launderettes as an example of traditional PSSs. Launderettes are facilitated by the interaction between consumers, employees, products, and other relevant infrastructures

PSSs shift the focus from transaction of products (i.e., single washing machine) to the provision of solutions based on bundles of products and services. In contrast to traditional services attached to products (e.g., warranty), the service in a PSS significantly adds value in the (daily) use to the consumer. For example, when buying a washing machine, a consumer may have access to a service warranty. However, while the warranty adds value to the experience of users with the washing machine (and provider), especially when the machine breaks, it does not particularly influence the daily interaction between the user and the machine or his/her use experiences with it (Figure 2.3). Moreover, the user is responsible for the maintenance of the machine, and he/she may access the warranty under very specific situations. In fact, the user may not access the warranty at all. In contrast, product and service in a PSS are both part of the solution and central to the interactions and experiences of the consumer with it. Products facilitate the provision of services (Vargo & Lusch, 2004, 2008) making them concurrent and interdependent. For launderettes, for example, several products, such as washing machines, dryers, folding tables, chairs, etc., and multiple services, such as helping personnel, coffee corners, etc., interact to create a holistic experience for users. Furthermore, users of launderettes are not concerned with aspects of the maintenance and durability of products; such responsibilities are taken over by service providers, further highlighting the focus on solutions rather than on individual products.

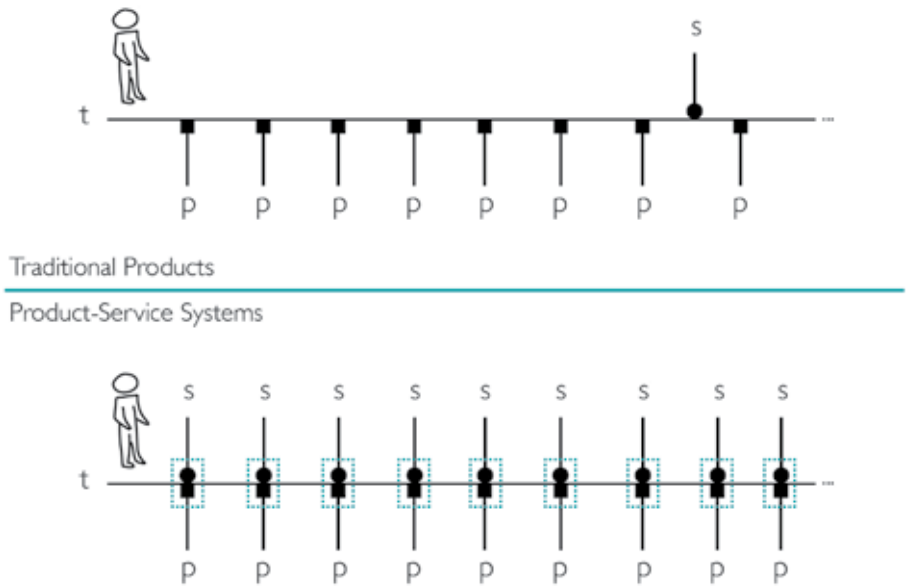

Figure 2.3 The difference in value in use of traditional products with attached services and a PSS. Both the product and the service in a PSS continously contribute to the value creation process of consumers

Consequently, PSSs are discussed as a strategy with resulting positive effects for providers, consumers, environment and society at large (Baines et al., 2007; Beuren, Gomes Ferreira, & Cauchick Miguel, 2013; Mont, 2002). For providers, PSSs are considered to increase the total value of market offerings and to lead to differentiating factors not easily replicable by competitors (Baines et al., 2007). For manufacturing companies, PSSs lead to more direct and increased interaction with consumers, improved communication, better understanding of consumers' needs, and thus, better value propositions (Reim, Parida, & Örtqvist, 2015). Overall, PSSs can influence the loyalty of consumers towards providers (Beuren et al., 2013). For consumers, the adoption of PSSs can result in flexible and customized solutions that better meet their needs (Baines et al., 2007; Beuren et al., 2013; Mont, 2002). The closer communication allows companies to co-create their offerings with consumers, which can result in solutions with improved perceived value and quality. Moreover, the development of PSSs can result in changes related to the distribution of responsibilities towards products (e.g., maintenance and serviceability). The adoption of PSSs can lead to significantly reduced tasks and responsibilities towards products by consumers, and shift the risk (e.g., financial) to providers (Reim et al., 2015). Finally, PSSs are discussed as a concept that can lead to positive effects on the environment and society at large. Providers' increased responsibility towards products can lead to specific actions to better manage the life cycle of products, for example, to increase products' durability, decrease product-related waste, or develop solutions with lower energy and material consumption (Beuren et al., 2013). This benefit has been discussed extensively in the sustainable production literature, among others, by Goedkoop et al. (1999), Mont (2004; 2007), and Tukker (2004).

2.1.2 Types of PSSs

As seen in the previous section, PSSs are composed of three elements: product, service and system. While these elements are common in all types of PSSs, the way they are delivered to consumers can vary from solution to solution (Reim et al., 2015). In this regard, business models have offered light into the possible variations between PSSs. Defined as "a system of interconnected and interdependent activities that determines the way [a] company "does business" with its customers, partners and vendors" (Amit & Zott, 2012, p.42), business models have been described in the PSS literature as a way to categorize PSS propositions that aid companies in the implementation of PSS strategies (e.g., Baines et al., 2007; Reim et al., 2015; Tukker, 2004). Three types of PSSs (i.e., PSS business models) are generally acknowledged in the PSS research field, with varying product-service ratios (Figure 2.4): result-oriented, use-oriented and product-oriented PSSs (e.g., Baines et al., 2007; Beuren et al., 2013; Tukker, 2004; Yang, Moore, Pu, & Wong, 2009):

Figure 2.4 The three types of PSSs generally acknowledged in the literature: result-oriented, use-oriented and product-oriented PSSs. Figure adapted from Tukker (2004)

In result-oriented PSSs, companies sell results or competences rather than tangible products. A specific product may not be pre-determined by the service provider, and may consequently play a less noticeable role in how the solution is delivered (Tukker, 2004). The ownership is usually kept with the provider, who is responsible for the maintenance and good performance of the product. Launderettes, previously discussed in this chaper, belong to this category. Other examples often cited in the literature relate predominantly to the business-to-business markets. For example, managed print services, where companies (i.e., customers) have a temporary contract with a service provider to manage their printing activities (e.g., http://www.managedprintservices.com). In addition to delivering printers, service providers guarantee quality of printing, lasting supplies and prompt maintenance. Customers pay a fee based on the amount of prints made and used supplies.

In use-oriented PSSs, products have a more prominent role. Different to result-oriented PSSs, providers of use-oriented PSSs sell the accessibility and use of specific products. Providers maintain the ownership of products while their goal is to maximize their use and lifespan (Baines et al., 2007). Examples in this category include the sharing, leasing and pooling of products (Tukker, 2004). In tools sharing, for instance, consumers pay to make temporary use of professional tooling for gardening, construction, and other purposes. Service providers make tools available through different service hubs around cities (e.g., http://www.boels.com). A consumer may select a hub based on a preferred location. After being used, the tools are returned to their pick-up location where other consumers can make sequential use of them. The service in tools sharing typically includes the maintenance of the tools, insurance, and assistance/information on how to operate the professional machinery (Mont, 2004). Consumers pay to access the tools easily but are responsible for cleaning the tools, returning them on time, and reporting any damages.

Finally, in product-oriented PSSs, a tangible product is sold and its ownership

transferred. Additional services are then offered to guarantee the correct functionality and durability of the product (Baines et al., 2007). Examples in this category include after-sales services (e.g., maintenance), needed during the use-phase of the product, or advise on how to operate the product (Tukker, 2004). Most examples provided in the literature relate to business-to-business transactions, where products are often described as parts of 'package' deals (e.g., including installation, maintenance, advice) and, as expressed by Tomiyama (2003), "a means to deliver services" (as cited in Yang et al., 2009, p. 225). For consumer goods, however, this product-oriented classification implies the use of conventional services that add limited value to the experience with the offering. For example, the purchase of a laptop computer may include a guarantee for reparations, replacement of parts, etcetera. These guarantees are, nevertheless, standard for many electric products and rarely increase the value in use of the product.

2.1.3 A characterization of Smart PSSs

Thus far, relevant concepts related to traditional PSSs have been discussed. In the following sections, we present our definition and characterization of Smart PSSs. The aim is to address the first research questions in a more direct manner: *What set of design characteristics can designers use while defining Smart PSS value propositions?*

As the concept of Smart PSS finds its origins in traditional PSSs, Smart PSSs share many of the traits discussed in the previous sections. Importantly, Smart PSSs are also composed of the three fundamental elements of traditional PSSs: the product, the service and the system. However, there are some important differences that set the solutions discussed in this thesis apart from those discussed in the traditional PSS literature: Products in a Smart PSS are smart, and connected, and the service through which providers and users interact is partly or completely electronic (i.e., e-service).

Smart Products

Smart products have been defined as market offerings characterized by the high content of information technology, and their ability to collect, process and produce information (Rijsdijk & Hultink, 2009, p. 25). For instance, automatic lawn mowers (e.g., Robomow, http://www.robomow.com) can be considered smart versions of the traditional lawn mowers. These machines are equipped with sensors that allow them to function with limited human intervention. Furthermore, contrary to traditional lawn mowers, the smart lawn mowers can be programmed to work at predefined times, and to automatically connect to a charging unit.

Several conceptualizations for the smartness of products have been proposed (e.g., Maass, Filler, & Janzen, 2008; Rijsdijk & Hultink, 2009). According to Rijsdijk

and Hultink (2009 p., 25), the smartness of a product is determined by the extent to which it possesses, to a greater or lesser extent, one or more of the following dimensions: autonomy, reactivity, adaptability, multifunctionality, the ability to cooperate with other devices, the human-like interaction of the product, and personality.

Autonomy refers to the extent to which a product is able to operate and reach functionality goals without the intervention of the user. For example, Philips' Direct Life (http://www.directlife.philips.com) is a Smart PSS designed to improve the health of consumers. The product in Direct Life is a small sensor that consumers can carry with them to measure their movements. This sensor is coupled with an e-service (i.e., a web platform) that consumers can access in order to 1) store the personal data that were measured during the day, 2) to access descriptive graphs of their chronological developments, and 3) to get in touch with health experts for professional advice on how to use the data to improve their health. Thus, Direct Life is an autonomous Smart PSS because the sensor measures movement unobtrusively throughout the day and transfers these data automatically to the web platform.

Reactivity relates to the capacity of a product to react to its environment. For example, Direct Life is reactive because it automatically detects when sensors are in motion, collecting and recording data from the user without his/her physical intervention. Moreover, *Adaptability* refers to how well a product can adapt its functionality to changes in the environment, overtime, resulting in better performance of the device. Relating this dimension to our previous example, we can say Direct Life is adaptable because it bases its measures on personal information, such as age or weight. As the data collected by the Smart PSS corresponds to the user's personal situation, the advice provided through the e-service is also personal and adjusted to the evolving physical condition of the individual user, over time.

Multifuctionality refers to how a product can be used for various functions. Direct life is not multifunctional because it has only one function, which is to track activity of users over time. However, other newer, commercially available products working as activity trackers (e.g., Fitbit, www.Fitbit.com; and Apple Watch, www.apple.com/watch) can fulfill multiple functionalities, including a watch, an alarm, or email notifier. *The ability to cooperate with other devices* indicates the degree to which a product can work in cooperation with other devices, or systems (Porter & Heppelmann, 2014), to achieve a common functionality goal. Direct Life is able to cooperate with other devices because the data collected throughout the day must be transferred to a computer to access it. Hence, Direct Life is able to cooperate with different computers, allowing users to transfer and access their personal data. The last two dimensions of product smartness are the *human-like interaction* and *personality*. The former relates to the interaction between the user and the product, and whether the way of communicating has human traits, such as speech. The later dimension, personality, refers to whether the communication carries the properties of a convincing character, for example, being able to transmit emotion or empathy. Both dimensions,

Rijsdijk and Hultink argue, are believed to contribute to a positive user interaction and understanding of the product. In the case of Direct Life, the sensor itself (i.e., smart product) does not posses either of the two dimensions. However, the dimensions are present when the sensor is combined with the e-service, as users can exchange emails and receive feedback from real coaches (Secomandi, 2012).

In sum, smart products can possess one or several of the above dimensions, and in a greater or lesser extent (Rijsdijk & Hultink, 2009). According to Rijsdijk and Hultink, non-smart products can also possess some of the above dimensions, but in contrast, their functionality in not mediated by IT. In the case of Smart PSSs, the solutions are 'smart' because they too rely on IT to mediate their functionality and the delivery of services. Hence, the dimensions of product smartness also apply to Smart PSSs, and as seen from the Direct Life example can present variations in the relevance or prominence of smartness dimensions.

From Smart Products to Smart PSSs

The transition from smart products to Smart PSSs has been made possible thanks to the Internet of Things (IoT); advances in Information and Communication Technology (ICT) that have allowed smart objects to generate digital data, connect to the Internet and interact with other devices autonomously (Kortuem, Kawsar, Sundramoorthy, & Fitton, 2010). Smart connected products create opportunities to use user-specific data to deliver value propositions, both in the Business-to-Consumer (B2C) and Business-to-Business (B2B) markets (Atzori, Iera, & Morabito, 2014).

An important difference between smart products and Smart PSSs is that the latter integrates an e-service with the smart product to jointly address the needs of consumers (Figure 2.5). Most of these services are e-services that deliver value to consumers through electronic means (Stafford, 2003). Smart PSSs have the capacity to transform data into knowledge that can help consumers perform more effectively (Davis & Botkin, 1994). In the case of Direct Life, the e-service is a fundamental aspect of the Smart PSS because it mediates the interaction between the user and the service provider, facilitating the access to data and interaction with health experts, who in turn, help interpret information and set personal goals to achieve a healthier lifestyle. The role of this "service interface" has been highlighted by Secomandi (2012), who describes it as "the ultimate object of design, because [it] is where new service materializes in the embodied experiences of those who produce it" (p.146).

Several benefits of implementing e-services in products for consumer use have been reported. One important benefit is their capacity to support a two-way dialogue between consumer and service provider (Rust & Kannan, 2003). Through the course of this dialogue, providers can collect specific information about consumers, which facilitates the creation of customized services to satisfy their individual needs. Furthermore, self-service technologies have been reported to provide a sense of control to consumers who can handle their transactions any time they want

(Meuter, Ostrom, Roundtree, & Bitner, 2000). To make optimal use of the benefits of e-services, Rust and Kannan (2003) predicted an increase in technology-enabled innovations, capable of supporting the delivery of e-services to consumers, which allow consumers to experience a high level of control over their transactions. We argue that Smart PSSs are such technology-enabled innovations, which will create new dynamics in the relationship between the service provider and the consumer.

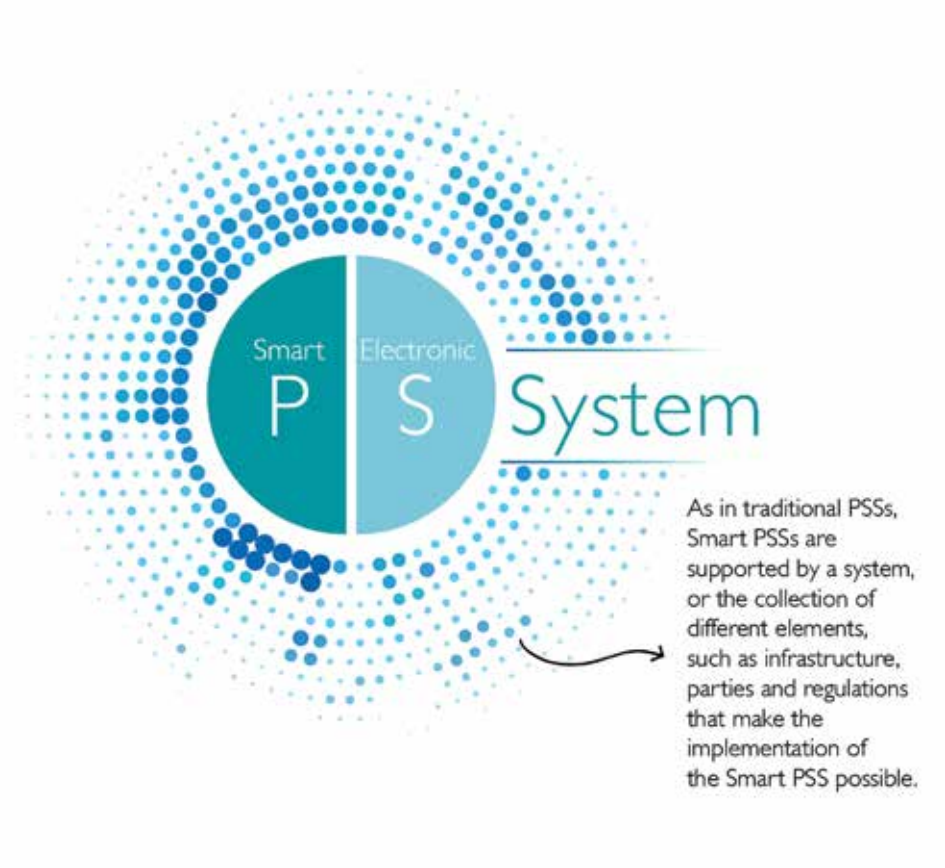

Figure 2.5 Smart PSSs: The integration of smart product(s) and e-service(s) to jointly address the needs of consumers

2.1.4 Typology of Smart PSSs and implications for this research

Section 2.1 had the goal of shedding light into the following question: *What set of design characteristics can designers use while defining Smart PSS value propositions?* The posed question was based on a deeper motivation to understand how designers can develop propositions with increased value for consumers. Consequently, an

important question to be answered is: Is the existing information sufficient to support designers' work in developing meaningful solutions?

To our knowledge, there is no generally acknowledged typology of Smart PSSs that can be used in the design of these types of solutions. Our review of the literature and characterization of Smart PSSs has shown that Smart PSSs can vary in their degree of smartness. The several dimensions of product smartness highlight the potential for designers to use technology in the smart product to create innovative and meaningful experiences for users. However, these dimensions do not discuss the integration of smart products with e-services, and the unique opportunities such integration can lead to in the creation of Smart PSSs. Thus, more information is needed that can help understand the Smart PSS concept and its implications for the development of value propositions to consumers.

Several aspects of the characterization of traditional PSSs could be of significance for designers working with Smart PSSs. The typology based on business, albeit relevant, could benefit from a further understanding of aspects of the user interaction and experience with the system. A distinction on business models hints towards differences in experiences for users of Smart PSSs (i.e., the experience with a product owned by the user may vary from that with a product owned by the provider). However, it does not specify the characteristics of Smart PSSs that can vary to create different experiences. Value creation (or co-creation; Vargo & Lusch, 2004, 2008) takes place in the interaction of the user with the system. Thus, as smart product and e-service are interfaces for user interaction with the system (Secomandi, 2012), their definition and characterization play a key role in the meaning and value consumers attach to Smart PSSs. More detailed information is required at the tactic level, such as product and service design aspects (Reim et al., 2015), which can help overcome consumer-related barriers for adoption, and contribute to the effective implementation of Smart PSS strategies. Designers could benefit from a characterization of Smart PSSs that can be used across contexts, identifying aspects of the Smart PSS that can be adapted to different use contexts (Morelli, 2011).

Furthermore, important differences between traditional PSSs and Smart PSSs (e.g., the ICT in the product) may result in new and critical opportunities for designers. As discussed, the dimensions of product smartness, and the increasing connecting capabilities of smart products, bring great potential for the implementation of innovative e-services. For designers of Smart PSSs, it is important to understand how the combination of smart products and e-services can lead to new types of interactions, improve the relationships between the stakeholders involved in the Smart PSS (i.e., users, employees, community, companies at large), and enhance the perceived value of the system over time.

The goal of Chapter 3 is to address the knowledge gaps we have outlined. By uncovering the characteristics of Smart PSSs, we aim at enhancing the understanding of these types of offerings. In particular, our goal is to develop new knowledge that

can facilitate the definition of value propositions, which can be adapted to different user needs and contexts.

2.2 How can designers support the design process of Smart PSSs?

Section 2.1 discussed aspects related to the definition and characterization of Smart PSSs. In this section, we explore aspects related to the design process of Smart PSSs and its organization. As in Section 2.1, we review the existing literature on traditional, industrial PSSs to derive the plausible aspects of Smart PSS design. In particular, this section explores the following three topics:

- The elements of the PSS design process: special traits that can lead to specific opportunities or challenges;
- The barriers and challenges in the implementation of PSS strategies; and,
- The potential roles/contributions of designers in the PSS design process.

Attaining a better understanding of the organization of Smart PSS design, and its implications for designers, allows designers (and design managers) to gauge the need to adjust their best practices.

2.2.1 Elements of the PSS design process

The design of PSSs is described as the process of integrating products, services, and business models to create innovative solutions with added value for customers (Vasantha, Roy, Lelah, & Brissaud, 2012). Generally speaking, PSSs are developed when manufacturing companies add service components to their offerings (i.e., servitization), service companies add products to their service offerings (productization) (Baines et al., 2007; Tischner & Vezzoli, 2009), or a new company forms its new market proposition based on both (Figure 2.6).

An example of a 'servitization' case is Oral-B, a subsidiary brand of Procter and Gamble (http://us.pg.com). Oral-B has traditionally developed consumer products for mouth hygiene, including manual and electric toothbrushes, and dental floss. Recently, Oral B has servitized its electric toothbrush line by giving connectivity properties to its electric toothbrushes, enabling consumers to measure and collect and store data in a e-platform related to their tooth-brushing routines (http://connectedtoothbrush.com). Amazon (www. Amazon.com), conversely, is a company that has gone through a 'productization' process. Amazon was traditionally known for their e-commerce activities, selling books, DVD's, baby products, beauty products etc. through its online platform. However, in 2007, Amazon started commercializing the e-reader Amazon Kindle, which enabled users to browse, store and read books

and other digital media through it. Amazon Kindle was integrated with their already existing book sale business making the company's store more easily accessed by consumers.

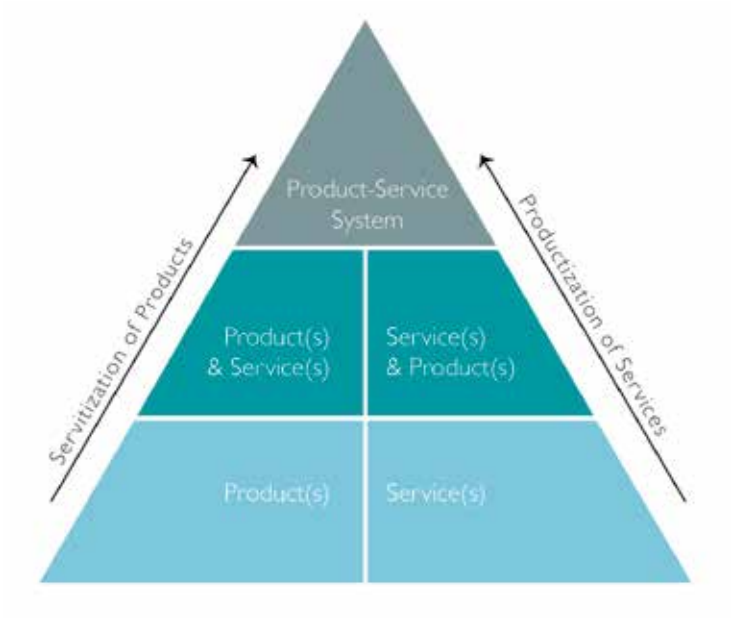

Figure 2.6 The 'Servitization' of products and 'Productization' of services to develop PSSs. Figure adapted from Baines et al. (2007)

Literature on traditional PSSs has highlighted the elements of the development process. Particularly, researchers and practitioners have outstandingly discussed the servitization process (e.g., Baines, Lightfoot, & Kay, 2009; Isaksson, Larsson, & Öhrwall Rönnbäck, 2009; Martinez, Bastl, Kingston, & Evans, 2010), defined as the journey companies follow in their efforts to transition from manufacturing to providers of PSSs (Martinez et al., 2010). Furthermore, Morelli has been pivotal in advancing the knowledge on PSS development process from a designer perspective (e.g., Morelli, 2002, 2003, 2006, 2011). Overall, the PSS development process has been described as entailing the following elements:

The simultaneous consideration of product and service characteristics

Different to product or service design, the development of PSSs requires the consideration of both product and service elements (Baines et al., 2009), to be developed in one integrated and coordinated development process (Isaksson et al., 2009). The product is a means to deliver services and value propositions (Vargo & Lusch, 2004).

Consequently, the characteristics of product and service must be carefully considered, seeking their complementarity to better support the implementation of PSS solutions. For example, a technical aspect of the product, such as remote monitoring, could be a prerequisite to timely product maintenance. Such is the case for ATAG One, the smart thermostat described in Chapter 1. In order to guarantee that the intended service of remote monitoring is effectively provided, the thermostat must be able to measure the correct data, and the e-services ought to display the measured information in a coherent and comprehensive way to support the communication between consumer and service provider.

However, despite the need to consider characteristics of products and services during the development of PSSs, in some cases, the development process may not entail the full design of an artifact at all, and designers may find themselves making use of existing products/technologies, designs by others, while designing new PSS solutions (Morelli, 2003). For example, Boels, the tools sharing PSS described in Section 2.1.2, does not develop the construction machinery offered to consumers. Instead, Boels has suppliers who provide the company with the necessary equipment for the provision of services.

The consideration of a large number of touchpoints

The development of PSSs requires the consideration of an increased number of touchpoints (Martinez et al., 2010). Implementing services means consumers interact with the system not only through the product but also through a number of different touchpoints. In the traditional PSS literature, for example, this element refers to the fact that employees at different levels of the organization, such as engineering and development, may find themselves interacting with the clients to help them solve product-related issues (Martinez et al., 2010). Thus, companies must account for aspects of the service not usually considered in traditional product design, such as the increased interaction between consumers and providers, and how to support this interaction (Baines et al., 2009; Martinez et al., 2010). Relating this element of the design process to Smart PSSs means that designers ought to consider the multiple touchpoints and interactions facilitated through the system, such as the smart product, the e-service(s), and in some cases (such as in the case of Direct Life), the communication with experts and other service employees, as well as their interrelation in the creation of user experiences.

The need to venture into unknown domains

The design of a PSS often requires a company to venture into new domains where it has little or no experience (Morelli, 2003). There is a need to make use of larger transdisciplinary design teams (Isaksson et al., 2009; Tan, Matzen, McAloone, & Evans, 2010), and to invest in the development of new capacities (Reinartz & Ulaga, 2008). For servitizing companies, this means acquiring new capacities to develop and

support the provision of services. For companies productizing their offering, such as Amazon, this means bringing in the capacities to design and produce products, as well as expertise, such as product engineering design, associated with these tasks.

The identification and organization of the development network

Multidisciplinary design teams are often called development networks, and involve the cooperation of different actors, such as manufacturers, service suppliers, governmental institutions and/or communities, which can influence the development of the system (Morelli, 2006). Consequently, the development of a PSS not only pertains the design of product and service elements. The development network enabling the implementation and delivery of the PSS must be crafted too in order to support the effective delivery of the envisioned PSS (Beuren et al., 2013; Isaksson et al., 2009). The organization of the development network involves the identification of business partners and other relevant institutes (e.g., government), which can influence the development of the system, as well as their relations (Morelli, 2006).

For example, imagine you are developing a PSS for shared transportation, such as that of OV-Fiets in the Netherlands. The OV-Fiets has been developed by the national railway system (http://www.ns.nl/en) to expand its services to the last portion of passengers' trips. The goal is to support the commuting activities of passengers after they exit the trains. The OV-Fiets is composed of bicycles that members can rent based on a 24 hours period. Bicycles can be found at diverse locations, such as train and metro stations, and parking facilities. Bicycles can be picked up and dropped off at these locations, and the maintenance of the bikes is the responsibility of the provider. In order to successfully develop a PSS like the one described, it is important to identify the stakeholders influencing its development. These collaborations contribute in different ways, for example, by providing knowledge needed in the development of the PSS (e.g., experts), materials (e.g., suppliers of equipment) or financial means (e.g., government). For example, it is important to identify who will provide the infrastructure for the provision of the PSS (e.g., public buildings, private terrain, etc.). Furthermore, local governmental institutions advocating a healthier lifestyle might help promote the use of the PSS. Suppliers for the maintenance of the bicycles may influence the design of the bicycles by setting requirements for maintainability. And operators of other similar successful PSSs may be invited to share their experiences and best practices.

The evolved role of consumers and suppliers through co-creation

While the element described above relates to the identification of relevant stakeholders, the present element relates to their collaboration towards the development of PSSs. Due to the high level of customization in PSSs, the design of PSS solutions require a deep understanding of consumer needs. Consequently, rather than being an input for development, customer insights need to be integrated/

embedded in the development process. To this end, the 'passive' role of suppliers, consumers, and other relevant stakeholders in traditional product development is evolved. Stakeholders cooperate closely through co-creation practices (Isaksson et al., 2009; Martinez et al., 2010; Morelli, 2006), for example, through workshops and think-tanks, exchanging relevant information and know-how related to needs of consumers and the design of solutions. As a result, the (effective) communication among stakeholders becomes a key aspect to the development of PSSs, to meet the needs of consumers effectively (Isaksson et al., 2009).

The adaptability of solutions: Responding rapidly to consumers' needs

Finally, different to the development of products, and in order to become service oriented, PSS development requires responding rapidly to consumers' needs (Martinez et al., 2010). Issaksson and colleagues (2009) discuss the PSS development process as being life-long and continuing through the life-cycle of the PSSs. As new needs arise, companies ought to react rapidly adapting the PSSs to the changing needs of consumers. Furthermore, the development of traditional PSSs often leads to solutions that are developed for a specific context or problem a consumer has. However, PSS design processes should lead to flexible solutions (or modules; Morelli, 2011, 2015) that can be combined in different ways, adapted to the varying and evolving needs of different consumers (or the same consumer), and over time (Isaksson et al., 2009; Morelli, 2011).

2.2.2 Challenges in the implementation of PSS strategies

While the elements described above have been mostly addressed in the servitizing literature, we expect them to also be applicable to productizing companies. The described changes service and manufacturing organizations encounter in the transition towards PSSs can lead to specific challenges (e.g., Baines et al., 2009; Isaksson et al., 2009; Martinez et al., 2010). For example, Martinez et al. (2010) identified five categories of issues influencing the servitization process: 1) the embedded product or service culture; 2) the strategic alignment (of the development network); 3) the supplier relationships; 4) the delivery of the integrated offering; and 5) the internal process capabilities.

'Embedded product or service culture' relates to the inherent product or service-oriented culture of organizations, and how it affects the implementation of the PSS strategy. Traditional manufacturing organizations may find a challenge in changing the mindset of employees and other relevant actors from the development of products (which are transaction-based) to the development of PSSs (which are relationship and solution-based). For example, in contrast to traditional products, the development and provision of PSSs may imply faster decisions around product and service development, as discussed in the previous section, to support the changing needs of consumers and effective delivery of the PSS (Martinez et al., 2010).

This challenge also applies to designers, as they may no longer be confronted with the design of a tangible product, but the definition of systems, the reorganization of existing technologies and people, based on the specific and changing needs from society (Morelli, 2003).

The second category, 'strategic alignment', is connected to the first one as it relates to the lack of a cohesive mindset of those in the development network that can slow the transition towards the provision of PSSs. Strategic alignment can take place inside the organization (as in the example above) when different functional units learn to think similarly, work simultaneously and cooperatively, in a service-oriented fashion (Isaksson et al., 2009). However, strategic alignment can also be a challenge between the manufacturing company and the new partners joining the development network. As new capacities are introduced to support the development of the system, companies ought to learn to communicate and co-create with different parties. However, different stakeholders may differ in their views and interests towards the PSS (Dougherty, 1992), or lack a common language that can be communicated and understood by all types of actors, including end-users (Morelli, 2015). In a similar fashion, the third category, 'supplier relationships', refers to the relational issues described above, in terms of communications and alignment of roles, but in relation to suppliers (Martinez et al., 2010). For example, in failing to see suppliers as co-creators of the solution and strategic partners.

Furthermore, 'the delivery of the integrated offering' refers to the several challenges companies face in bringing the PSS solutions to the market. First, some of the personnel of servitizing companies interacting with consumers may not be service oriented and/or trained to do so, which can lead to significant variations in how consumers experience the interactions with the supplier. Thus, creating uniformity in the interactions between consumers and the system is a challenge. Second, consumers may also lack a solution mindset, failing to see a solution as an integrated whole instead of the individual elements that compose it (i.e., stepping away from the transaction-based relation), making it particularly important for companies to communicate the value of the PSS effectively. Third, while flexibility in PSSs allows for the development of customized solutions for different consumers, it also can lead to challenges in maintaining the same level of quality in the PSS offering, across consumers and over time[7] (Isaksson et al., 2009). And fourth, due to increased complexity of PSSs, such as the increased number or actors and shifts in accountabilities, the drafting of contracts and other details of the PSS business is a challenge. PSSs contracts include aspects generally not considered in product design, such as the aspects of the service delivery, which further complicate their definition for servitizing companies (Isaksson et al., 2009).

Finally, companies may lack some of the key 'internal process capabilities' needed

7 Conversely, due to the high context dependency of PSS solutions, reproducibility and scalability of PSSs have been deemed a challenge, particularly in the social innovation context (Morelli, 2015).

in the development of PSSs. First, companies, and designers, may not have the necessary tools and methods, appropriate for the special traits of PSSs (Morelli, 2006). For example, some authors have discussed the difficulties in modeling or illustrating the system, depicting both product (i.e., tangible pieces, parts, etc.) and service aspects (i.e., intangible aspects, such as encounters, time and place) (Isaksson et al., 2009; Morelli, 2002, 2009), and how the different aspects interact in the provision of solutions. Such representation of the PSS is important because it can impact the effective communication among stakeholders, helping to form a shared idea on the solution to be developed (Morelli, 2002, 2006). Second, servitizing companies may lack the tools and methods that allow them to assess the effectiveness of internal capabilities, as they are set up for product development (Isaksson et al., 2009; Martinez et al., 2010). Companies may find challenges in adjusting these measures, for example, by reestablishing key performance indicators that respond to the provision of solutions and development of relationships with customers.

2.2.3 Potential roles/contributions of designers to the design of Smart PSSs

As discussed in the introduction to this chapter, the design management literature has long discussed the plausible roles and contributions of designers to organizations; both in executing an effective design process and creating products/services that are valued by consumers (e.g., Brown, 2008; Celaschi et al., 2011; Mozota, 2002; Trueman & Jobber, 1998; Valencia et al., 2013). For example, in a case study conducted by Valencia et al. (2013), the authors found that designers of a high-tech development company contributed to the design process in four different ways: 1) by helping communicate relevant external information, such as changes in trends that can influence the development process, 2) by facilitating the communication between different functional areas, for example, through the use of visualizations that promote the shared understanding of design goals, 3) by integrating the feedback and requirements of different stakeholders into concrete propositions for product development, thereby stimulating the balance in the design process, and 4) by embodying the marketing message in the product, supporting the development of the story around the product and thus marketing activities around new products.

In the case of PSSs, it is relevant to explore how designers can contribute to the design of PSSs, in light of the changes and challenges organizations face in the implementation of servitized products. In this regard, the work of Morelli is of particular relevance (e.g., Morelli, 2003, 2006, 2009), as he has discussed the implications for designers in the distinct context of PSS development.

First, designers can contribute to the analysis and interpretation of the design context. Designers can contribute to the investigation of the needs, motivations and barriers for adoption of PSSs (Morelli, 2002), not only by consumers but also of stakeholders involved in the development of the PSSs (i.e., development network).

For example, designers are equipped with toolsets and methods, such customer journeys, cultural probes, contextmapping, and other ethnographic techniques, and designers' expertise in their use can be critical in the understanding of the context. Second, designers have a role in the selection of artifacts and technologies to be used in the implementation of the PSS. Morelli describes designers as being synthesizers in the design process who help set criteria (e.g., based on their understanding of the context) to evaluate the appropriateness of designed solutions (2003). Furthermore, he describes designers as capable of dealing with complex information and helping mediate the selection of artifacts and configuration of solutions (Morelli, 2006, 2009).

Finally, designers are involved in the organization of the PSS development process and the organization of the development network; an activity closely related to that of design management (Morelli, 2002, 2006). Designers can help to create a collaborative atmosphere in the development process (Morelli, 2009). To this end, he stresses the need to equip designers with tools to: 1) help identify and profile different actors, understanding their relations and interactions 2) discuss different use scenarios that can lead to different PSS solutions, and to different configurations of the development network (i.e., system, Morelli, 2009), 3) represent and visualize the system, including the product and service elements of the PSS, and to facilitate the communication during the development process. Through his work, he has suggested a set of tools, such as use cases, interaction maps, and service blue prints, which can aid designers in the aforementioned activities (Morelli, 2006). However, the author stresses the need for repurposed and new tools that can support the design of PSS and their unique elements, and to further develop a distinctive toolset for PSSs design, for designers.

2.2.4 The organization of Smart PSS design and implications for this research

The purpose of section 2.2 was to shed some light into the following question: *How can designers support the design process of Smart PSSs?* To this end, literature on traditional PSS development was explored, which could bring clarity on the organization of Smart PSS design and the aspects that influence this process. Three particular aspects were reviewed: The elements of the PSS design process, the challenges organizations face in the transition to PSS strategies, and the roles/contributions of designers to the PSS design process.

The elements of PSS design described in Section 2.2.1 are largely the result of the service that makes part of the PSS solution. For example, services have been described as being co-produced in relationships, networks, and through interactions (Gummesson, 2002), which draws a parallel with PSS design. Service design, too, encompasses the consideration of multiple touchpoints, such as the case of banking, experienced through paper statements, bank personnel, ATM machines, etc. (Løvlie,

Downs, & Reason, 2008). Furthermore, challenges in the design process of PSSs arise from the distinct elements of the design process, related to its organization (e.g., increased complexity in design and decision making due to the larger number of stakeholders in the development network), but also to the characteristics of the solution that is developed (e.g., considering multiple touchpoints during the design process, leading to problems in visualizing and communicating solutions). Importantly, the work of Morelli suggests that designers can make important contributions to the PSS design process, for example, in understanding the problem/context of design, designing, and facilitating the communication in co-production activities (Morelli, 2009), which help to tackle specific challenges of the PSS design process (Figure 2.7).

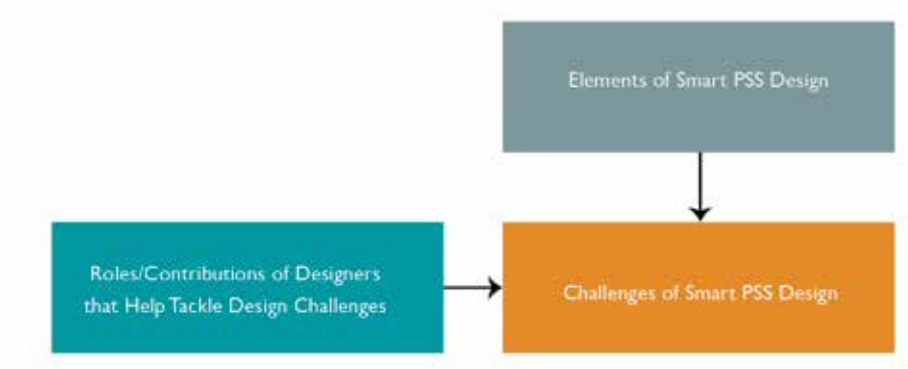

Figure 2.7 The possible contribution of designers to the Smart PSS design process. Elements of Smart PSSs design lead to specific design challenges. Designers are equipped to help tackle design challenges in Smart PSSs by the use of their capacities

We expect the elements, challenges and contributions of designers discussed through Section 2.2 to also apply to Smart PSS design. However, Smart PSS design may have distinct elements and challenges compared to those of traditional PSS design, derived from, and emphasized by, the technology-enabled traits of these propositions.

For example, the OV-Fiets described earlier in this section, could be considered a traditional PSS that is slowly transitioning towards a smart solution. The current version of the PSS allows for some limited interactions through a web portal, such as identifying the location of bicycle hubs in a map, the number of bikes available, and rating customer satisfaction. However, the web portal is not yet a central part of the user experience and interactions with the system. Consumers cannot book a bicycle through the portal, get in touch with the service provider in an interactive way, or access personal information, such as kilometers pedaled linked to activity indicators

(e.g., calories burned, see Bicing https://www.bicing.cat/es). Thus, OV-Fiets still relies largely on human-to-human interactions facilitated by the employees of the railway system. In this particular case, the transition towards a Smart PSS could raise questions and challenges for designers related to the different e-services and touchpoints to be implemented; for example, in how to create cohesiveness through all digital (i.e., e-services) and physical points (i.e., railway stations, bicycles), and avoiding the de-humanization of the system (Pinhanez, 2009).

Furthermore, the existing literature addressing the transition to PSSs largely relates to industrial solutions, where services relate to a great extent to maintenance and parts' supply. Thus, to better provide advice to designers on how to support the Smart PSS design process, it becomes imperative to explore the design process from this particular standpoint. Consequently, our goal in Chapter 4 is to deepen our understanding of Smart PSS design, expanding our knowledge in relation to the three aspects explored in this section: the elements of the design process, the design challenges, and roles/contributions of designers that help tackle design challenges.

2.3 How can designers trigger positive consumer responses with Smart PSSs?

So far, through the introduction and literature review of this thesis, we have highlighted the implications for consumers of adopting Smart PSS solutions. For example, Chapter 1 presented several anecdotes related to consumers of Smart PSSs and the difficulties they experience with these systems. Next, Section 2.1.1 highlighted the role that both product and service play in the value creation–in use–of PSSs. And in Section 2.1.3, we stressed the different benefits of smart products (e.g., adaptability of the solution to different environments) and e-services (e.g., two way communication for providers), and their potential implications for consumers.

Despite the benefits Smart PSSs may represent for consumers, companies and designers may face an important challenge in creating Smart PSSs that lead to positive experiences for consumers. Think for example of the case illustrated in Section 1.2, where issues with data accuracy and connectivity influenced the experiences of Google's Nest users and their trust towards the PSS and provider. Furthermore, as discussed in Section 2.2.2, an important barrier to the adoption of traditional PSSs is the potential struggle of consumers to understand the value proposition that the PSSs comprise. As discussed by several researchers (e.g., Baines et al., 2007; Beuren et al., 2013; Martinez et al., 2010), consumers may require a change in mindset, moving away from the single transactions of products that are owned, to solutions that are oftentimes "ownerless" (such as in solution-oriented PSSs) and developed on the basis on services (composed of several transactions, people, information), and thus, long relationships with the providers.

With these potential issues in mind, the goal of this section is to shed light into the

factors that can influence consumers' (i.e., end-users') experiences with Smart PSSs, thereby affecting the perceived value-in-use and responses towards the proposed solutions. Understanding the aspects influencing the experience and value in use of Smart PSSs is of great relevance for designers, as they can shape the experience of consumers through the service interfaces and help them achieve their goals towards Smart PSSs (Secomandi, 2012). But, what is user experience, and what factors influence it?

2.3.1 User experience

'User experience' (i.e., UX) is a term commonly used by the human-computer interaction community. The term relates to how technologies–in the interaction with the user–can "fulfill more than just instrumental needs" of users (Hassenzahl & Tractinsky, 2006, p.95), for example, by creating joy and emotion. Furthermore, UX is influenced by 1) the intrinsic aspects of the user; such as needs, expectations, and mood, 2) the characteristics of the design technology or system, such as its usability and functionality, and 3) the context in which the encounter with the technology occurs (Hassenzahl & Tractinsky, 2006).

In the service marketing literature, Sandström, Edvarsson, Kristensson, and Magnusson (2008) present a definition for service experience with technology-based services (e.g., ATM, mobile banking) that is based on the service-dominant logic theory (Vargo & Lusch, 2004). Service-dominant logic sees value as a co-creation process between consumers and service providers. According to this theory, providers create value propositions by designing (e-)service processes and content that can be accessed by consumers. However, it is only through the interaction of consumers with the e-service that value is actually built, making consumers active contributors to the value creation process (Gummerus, 2010).

Continuing with the definition of service experience, Sandström et al. (2008) see this service experience as influenced by the value propositions embodied in 'physical/technical enablers', such as the infrastructure supporting the provision of the system, or the interface through which consumers interact with the provider. The value proposition carried in these enablers can be of a functional (e.g., measuring physical activity) or emotional (e.g., gaining status by owning the newest gadget) nature. Furthermore, Sandström et al. argue for the role of 'individual and situational' filters in the value consumers derive from propositions. In other words, the value co-creation process is unique to each individual consumer, as each consumer has specific needs, motivations, and other contextual factors, which can influence his/her experience with the service.

In a similar fashion, and based on an extensive review of the literature, Rose, Hair, and Clark (2011) developed a framework to better understand the antecedents and consequences of online customer experience (OCE) in e-commerce. The authors

describe the OCE as being influenced by aspects (i.e. antecedents) that are processed by consumers in a rational (e.g., processing information based on past, present and future experiences/expectations) and an emotional way (e.g., enjoyment). These cognitive and emotional states lead consumers to have individual attitudes and believes towards e-services, and influence their decisions to continue using the service or re-purchase the offering. The list of antecedents influencing OCE is extensive and based on aspects taken from behavioral science and psychology. Thus, providing a detailed description of each antecedent is outside the scope of this research. However, it is worth noting that similar to Sandström et al. (2008), Rose et al. also mention antecedents to OCE that could be considered aspects embodied by 'physical/technical enablers'. For example, they list usefulness of the website, or the degree to which the website and its content fit the daily life of the consumer, as an aspect influencing the OCE. Furthermore, they mention antecedents to OCE that could be considered 'situational filters', such as the skills or proficiency of users with technologies or the trust propensity, a personality trait, defined as "a general disposition to trust people in life" (http://megatron.iiia.csic.es/mediawiki/index.php/Trust_propensity).

In sum, user experience is influence by several aspects, some of which can be manipulated by designers, and others, which cannot (Figure 2.8). For example, the characteristics of a smart product, such as its ergonomics and materials, can be manipulated to make it more pleasant to touch. Or the e-service can be created with characteristics that can help consumers achieve their goals more easily, for example, by allowing the personalization of the interface to match one's preferences. These 'manipulable' aspects are value propositions that can influence the experiences of consumers. Furthermore, the value derived from the experience is individual, and influenced by aspects of little control to designers, such as their attitudes towards technologies (Sandström et al., 2008).

2.3.2 Characteristics of products and services

Products and services have different characteristics that influence how consumers interact with them. Products are tangible, making it possible for consumers to use their senses to evaluate them; sight, touch, smell, hearing can come into play to infer the relative quality of products. For example, past research has demonstrated that the appearance of a product can play a key role in consumers' choice of products, for example, by having products that are aesthetically pleasant, that communicate consumers' personality, or that look durable (Creusen & Schoormans, 2005). When evaluating a conventional watch, for instance, consumers may draw conclusions about the quality of the watch by touching the materials of the wristband, and checking for any visual mistakes of the finishing details.

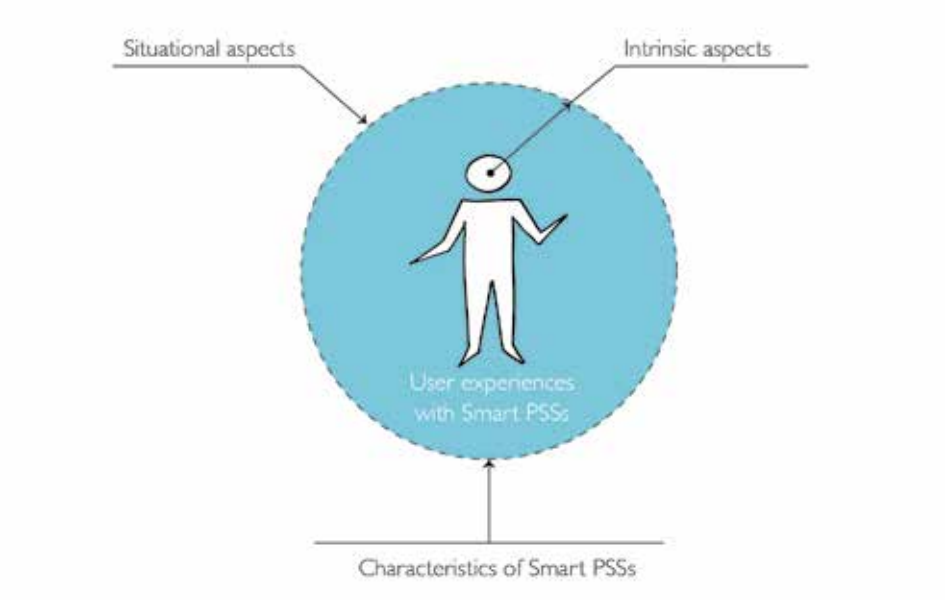

Figure 2.8 Aspects influencing the user experience with Smart PSSs. Three main aspects: situational aspects (e.g., context), intrinsic aspects (e.g., mood), and the characteristics of Smart PSSs

In contrast, services have been described as intangible; they encompass the activities of others, whose actions are not always evident (Parasuraman, Zeithaml, & Berry, 1985). Services have been described as heterogeneous, as their quality depends on variable factors, such as employee behavior and consumers' state. Furthermore, services are known to have inseparable production and consumption processes, as customers are active participants of the value co-production process (Vargo & Lusch, 2004, 2008). Finally, services are said to be perishable; they last for as long the customer interacts with them, and cannot be stored or returned (Parasuraman et al., 1985).

The intangibility and heterogeneity of services have deep implications for consumers' evaluations of services, as consumers lack a single and invariable element they can base their evaluations on. Instead, while experiencing services, consumers make use of different tangible cues available through the service to make quality inferences (Shostack, 1977, 1982). Service researchers have referred to these cues as the 'servicescape': "The environment in which the service is assembled and in which the seller and customer interact, combined with tangible commodities that facilitate performance or communication of the service" (Booms & Bitner, 1981, as cited in; Zeithaml & Bitner, 2000, p. 20). For example, the servicescape at a beauty spa could include elements, such as decor, wall colors, furniture, and towels. In a spa, providing white clean towels and packaged sleepers to customers can be perceived

as an attribute of hygiene. Servicescapes influence the experiences and perceptions of customers towards services; they are tangible evidence that can be sensed and experienced by customers, and help communicate value propositions by providers.

Consequently, while services are also evaluated using senses (just like products), the cues perceived in the experience are broader in nature. Some of them, such as the layout of the service, furniture, logo, and colors of the walls, can be strategically manipulated and determined by designers. Others, such as the mood of the employees (or consumers, as explained in Section 2.3.1), are more difficult to manipulate and will bring variability to the service experience. Servicecapes are a key aspect in the communication and interaction between service providers and customers; they influence the experiences of consumers, their perceptions, evaluations, and attitudes towards services, for example, in creating brand awareness, and helping categorize the service (Bitner, 1992). Consequently, designers can focus their attention to those aspects of the servicescapes that can be devised, shaping and managing the experience of consumers through tangible cues (Shostack, 1977, 1982).

2.3.3 Consumers' experiences and evaluations of Smart PSSs

We expect Smart PSSs to be evaluated on the basis of both products and services. The smart product of a Smart PSS is oftentimes owned by the consumer, and in some cases of great prevalence, for example, when displayed at home (e.g., ATAG One) or worn by the user (e.g., Fitbit). Furthermore, the concept of servicecapes means that consumers will have an increased number of cues influencing their experiences and evaluations of the Smart PSS. These cues include the e-service(s) and the smart product(s), but also others, such as the product packaging, installation instructions, and aspects of the system facilitating the provision of the service visible to the user, such as experts and help desk employees. Moreover, past research by Secomandi and Snelders (2011) has highlighted the role of the service interface in facilitating the interactions and exchange relations between consumers and providers, thereby shaping the experiences and perceptions of consumers towards services. We echo this view, and see the e-services of Smart PSSs as playing a key role in shaping the experiences and perceptions of users.

We expect the value proposition in a Smart PSS to be highly influenced by the increased number of quality cues, embodied in the different touchpoints (e-services), information and interactions facilitated by the Smart PSS. For example, a conventional sports watch with embedded heart-rate measurement capabilities works providing information for a single event in time, and through a single interface (i.e, the watch). The user sets the watch before a run and can monitor the hear-rate measurement while the activity (i.e., running) lasts. In contrast, a Smart PSS developed to support runners, such as Fitbit (www.fitbit.com), allows users to check information related to their running activities over time and over several distinct platforms. Users can store data and compare it day by day, month by

month, as well as access it through different platforms, such as the smart watch, the website, and the app. Thus, the interaction of consumers with Smart PSSs changes considerably to that of conventional products. Some of these changes may influence how consumers understand the value proposition, and their intentions to continue using the solutions.

In relation to *how* consumers experience the service interface (i.e., e-service) of Smart PSSs, the work of Secomandi (2012) is of particular relevance. Based on qualitative, post phenomenological research with users who interacted with a distinct Smart PSS over a period of 12 weeks, the researcher outlines the ways in which consumers experienced the e-service[8]. Secomandi uncovered that for the studied case, the e-service and the user were co-constituted; they were interrelated and could not exist independently from each other. The interface was not neutral to consumers; in line with research on e-service marketing (see Rose et al., 2011), users brought their previous personal experiences (i.e., proficiency with similar technologies), which helped them understand and interpret the interface in an individual way, and to take action accordingly. Through logos, illustrations, configuration of elements in the interface, and others, users were able to position themselves in the role of client in the interaction with the Smart PSS. This would imply that consumers with limited or no familiarity with similar systems have the risk of not understanding the interface readily, with potential negative implications for their experience with the Smart PSS.

Interestingly, Secomandi (2012) found that while the Smart PSSs influence social interactions (i.e., when others ask about the novel device you are wearing), these interactions are not always desirable. Thus, the adoption of Smart PSSs can also lead to negative experiences beyond the service interaction, which may be out of the control of the user. His findings are in line with previous research by Rexfelt and Hiort af Ornäs (2009), who found the adoption of a traditional PSS to be influenced by the impact of the solution on the daily lives of the consumer, beyond the interaction with the service; for example, in how it influences his/her interactions with others.

Furthermore, Secomandi (2012) highlights the need some users face of adapting their behavior to the new interaction with the Smart PSSs. In his study, users were interacting with Direct Life, a wearable sensor providing feedback on their daily activity (as previously described in Section 2.1.3). While for some users the smart product (i.e., sensor) is in the background and is barely noticed, for others it plays a more prominent role, for example, by having to come to terms with carrying the device everywhere in a comfortable and fashionable way. Moreover, the issue of adaptation related to trusting the feedback and information provided by the Smart PSSs; users often questioned the accuracy of the data measured through the sensor, seeking to understand how the information on their daily activities was computed.

8 The author refers in his work to service interfaces in general. However, his research is based on the use of a Smart PSS whose interface is electronic. Hence, to the sake of consistency in the present manuscript we use the word e-service when discussing the work of Secomandi (2011).

Finally, Secomandi (2012) found that users were able to make inferences about the personalities and best practices of service employees they interacted with through the service interface. Users were able to build 'relationships', positive or negatives, and to be motivated to continue using the service by such interactions. In contrast, automated service replies were perceived to have little relevance to users. This finding resonate with those of Pinhaez (2009), who argue that one of biggest challenges of online e-service design is the creation of platforms that can recognize the human aspects of the service exchange, such as emotions and contextual reactions, while allowing atomization and efficiency, but without de-humanizing the service (Pinhanez, 2009, p.7).

2.3.4 Implications for this research

The goal of Section 2.3 was to shed some light into the following question: *How can designers trigger positive consumer responses with Smart PSSs?* To trigger positive responses, designers must attain an understanding of the factors that can influence users' experiences and evaluations of Smart PSSs. The theories discussed throughout this section provide a first glance at those potential factors, and have implications for our study of consumers' experiences and evaluations of Smart PSSs.

First, we expect the intrinsic differences between products and services (discussed in Section 2.3.2) to represent a challenge for the successful integration of these elements from a consumer's perspective. The symbolic benefits that consumers experience in the various elements of a PSS may differ or even conflict. For example, a fully customized service element may provide the important symbolic benefit of self-expression because it conveys a person's uniqueness, whereas a standardized product element may fail to do so (Mugge, Schoormans, & Schifferstein, 2009). Failure to provide a congruent experience can be expected to confuse the consumer, and ultimately, damage the user experience. However, despite the relevance of developing congruent PSSs that are perceived as one total offering, research on how consumers experience the product and service elements of a PSS is limited. This research contributes to the literature by investigating how consumers experience and evaluate these particular offerings. Specifically, we aim at exploring the influence of congruity with respect to the conveyed symbolic meaning (i.e., by both the service and product elements) on consumers' evaluations of the PSS.

Second, the work of Secomandi (2012) is of relevance to the present research as it highlights the importance of the interface for the experiences of users, without disregarding the role that the smart product plays in the creation of such experiences. Furthermore, it highlights the role that designers can play in manipulating the interface to influence consumers' behaviors.

An important attribute of Secomandi's work is the fact that he explores the experiences of users with the Smart PSS *while in use*, over an extended period of

time. We support this approach in our research and follow the perspective of the service-dominant logic (Vargo & Lusch, 2004, 2008). Thus, we see value-in-use as achieved through the experience with the Smart PSS, through the interaction with smart product and e-service. If services are heterogeneous and dynamic, and evaluated by consumers at every step of the interaction (Pinhanez, 2009), it is reasonable to study consumers' experiences while considering the time dimension. Furthermore, if experiences are context dependent and individual to each consumer, the consideration of the context dimension becomes key in understanding consumers motivations for using Smart PSSs. However, the inclusion of time and place on studies of consumers' evaluations of e-services is predominantly lacking in the service literature (Heinonen & Strandvik, 2009).

Our research aims to build on Secomandi's work on consumer's experiences with Smart PSSs. An important limitation of his work is that his findings are based on the experiences with a particular type of Smart PSSs, designed to measure and provide feedback related to a specific activity of the consumers. However, the contexts for which Smart PSSs are developed are varied, and designers can benefit from further information on the different aspects that may influence the adoption of Smart PSSs in different contexts. Moreover, there is a general need for more specific information that can help designers manipulate the e-service interface and its integration with the smart product effectively. While Secomandi's research does employ a Smart PSS as stimuli, his focus lies on the service interface rather than the interplay between product and service elements, and their influence on the user experiences with both types of elements. Consequently, our goal is to attain a deeper understanding of the factors that contribute to the value creation process of consumers with Smart PSSs, influencing their experiences and evaluations. In particular, we are interested in understanding what motivates consumers to continue using the Smart PSSs over time. To this end, we aim at collecting insights that are situational, context related and qualitative in nature. Our goal is to contribute to the literature by gathering rich information that can help us understand the (changing) needs of consumers towards Smart PSSs, and what design actions can contribute to triggering positive responses from consumers.

2.4 Closing remarks

Overall, it can be concluded that Smart PSSs are still relatively young market propositions, with great potential for creating innovative and durable experiences for consumers. The several characteristics of smart products and e-services, when combined, give designers the opportunity to create innovative interactions and services that consumers can benefit from. Moreover, based on the literature on traditional PSS design, the design process of Smart PSSs promises to be a complex one, with the increased number of touchpoints and stakeholders seemingly influencing the challenges that designers face to a great extent. Finally, consumers'

experiences with Smart PSSs, and their evaluations of these offerings, promise to be a complex process influenced by intrinsic and contextual aspects of the consumer, as well as 'manipulable' aspects of the proposed solutions, for example, the general characteristics of the Smart PSS. Importantly, throughout these apparent challenges, designers appear as important contributors to the decisions around the three explored areas: characteristics of the Smart PSS (i.e., proposed value), the organization of the design process, and the experiences of consumers (i.e., image and evaluations).

In general, the literature on Smart PSS design is young, and designers can benefit from more empirical evidence that can guide their practices in a more informed way. For each of the outlined research questions, theoretical gaps were identified, which guide our research efforts. Thus, the overall contribution of this thesis is the broadened understanding of Smart PSSs, in relation to the two perspectives, three topics and research questions previously discussed (Figure 2.9), of relevance for the design community. By deepening the design-related knowledge in each of the questions outlined, we provide designers with practical guidelines and insights to facilitate the design management of Smart PSSs.

Each of the following three chapters addresses one of the research topics discussed in this thesis. The (main) research question and sub-questions within each topic are investigated by means of several empirical studies.

Chapter 3 focuses on the topic 'characteristics of Smart PSSs'. As no sub-questions were identified for this topic, the aim of Chapter 3 is to deepen the knowledge in relation to its main research question: *What set of design characteristics can designers use while defining Smart PSS value propositions?* The question is investigated by means of Study 1-a and Study #1-b.

Chapter 4 focuses on the topic 'the Smart PSS design process'. The research question in this topic is the following: How can designers support the design process of Smart PSSs? Three sub-questions are outlined, in accordance with our review of the literature: *What are the elements of the Smart PSS design process? What are the challenges of Smart PSS design?* And, *What are the designer roles/contributions that help tackle design challenges?* These questions are investigated by means of Study #2.

Finally, Chapter 5 centers on the topic 'consumers' reactions to Smart PSSs'. The main research question in this topic reads as follows: How can designers trigger positive responses with Smart PSSs? For this topic, three sub-questions guide our research efforts. Study #3 aims at answering the following sub-question: *What is the effect of coherence between product and service elements on consumers' evaluations of Smart PSSs?* Moreover, Study #4 addresses two specific sub-questions: *How do consumers' experiences with Smart PSSs develop over time?* And, *What factors should designers consider when defining experiences with Smart PSSs?*

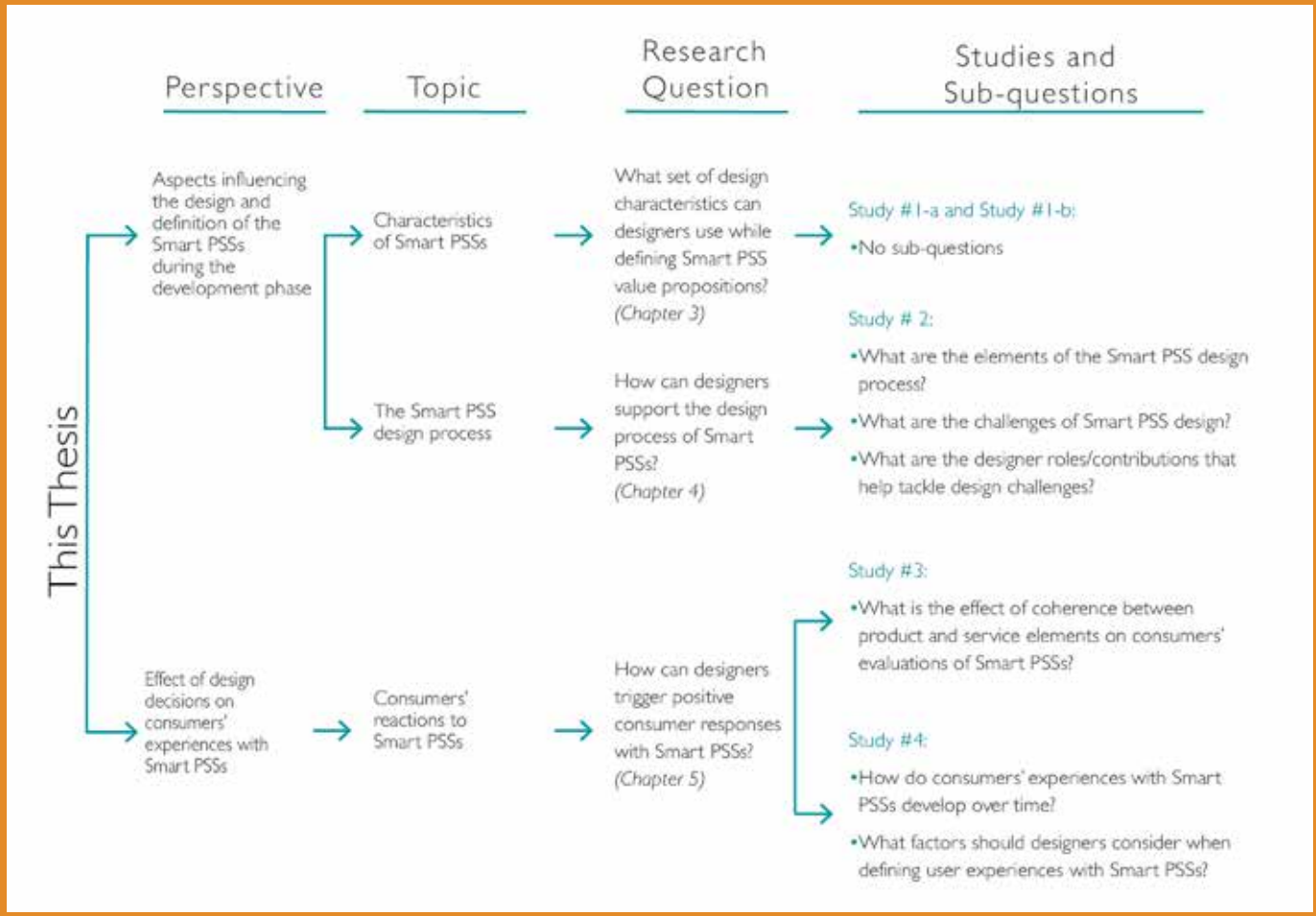

Figure 2.9 Perspectives, topics, research questions and sub-questions in this thesis

Image source: http://news.nike.com/nike--3

3. Characteristics of Smart PSSs[9]

9 This chapter is an adaptation of: Valencia, A., Mugge, R., Schoormans, J. P. L., and Schifferstein, H. N. J. (2015). The Design of Smart Product-Service Systems (PSSs): An Exploration of Design Characteristics. *International Journal of Design*, *9*(1), 13-28.

In Chapter 2, a conceptualization for Smart PSSs was presented (Section 2.1). Based on a review of the traditional PSS literature, the business models that can be implemented to bring Smart PSS propositions to the market were discussed. Furthermore, some of the expected characteristics of Smart PSSs with potential implications for the experience of consumers were identified, such as the adaptability of the smart product, and the capacity of the e-service to support the two-way communication between provider and consumer.

However, an important conclusion from the literature review was the inadequacy of the existing information to fully support designers' work in the definition of new Smart PSS value propositions. Particularly, we identified a need to better understand the opportunities derived from the integration of smart products and e-services, described in terms of design characteristics, which can be used and adapted by designers to different use contexts and business models. Consequently, the aim of Chapter 3 is to find a more specific answer to the following question:

> ***What set of design characteristics can designers use while defining Smart PSS propositions?***

The goal is to explore the defining characteristics of Smart PSSs, relevant for the creation of meaningful user experiences and interactions. Understanding how Smart PSSs can create meaningful interactions is important, because it can support the

development of design propositions that foster long-lasting relationships between providers and consumers. The aim of this chapter is to bring forward knowledge that can help designers make more informed decisions around the design of Smart PSSs. Understanding the characteristics of Smart PSSs can lead to the creation of such market offerings with increased value for consumers, especially over time.

To meet our research goal, two distinct studies were conducted. Study #1-a had an exploratory character, and aimed at identifying a first set of characteristics of Smart PSSs. To this end, examples of Smart PSSs were discussed with industrial designers holding a bachelor degree by means of a classification task. Study #1-b aimed to validate and extend the findings of Study #1-a, by discussing them with a group of designers who have experience with the design of Smart PSSs. The remainder of this chapter reports these two research activities; methods, findings and conclusions.

3.1 Study #1-a

3.1.1 Method Study #1-a

In-depth interviews were conducted with industrial designers who held a bachelor degree in industrial design (N=16). Our group of participants was composed of recently graduated and second-year master students of industrial design. Consequently, participants were well trained to understand how users experience and interact with products and services. Because of their professional experience and study curriculum, participants had taken part in various real-life project scenarios that granted them a critical view of user needs and general product/service requirements.

During the interviews, participants were asked to analyze 29 commercially available smart and traditional PSSs, and to classify them according to their perceived similarities. The goal of this classification task was to uncover the characteristics (i.e., criteria) used to group similar sets of market offerings (Mugge et al., 2009). Given the focus on Smart PSSs, it was particularly important to enroll participants who were capable to rationalize and explicate their grouping decisions in design-related terms. To elucidate design characteristics, participants were encouraged to group stimuli on aspects related to the user interaction and/or experience. Establishing this mindset was important to avoid categorizations based on more general product features, such as shape and category. Participants had the freedom to decide the number of groups and examples of PSSs belonging to each group (Handelt & Imai, 1972).

Stimuli

Based on extensive Internet research and discussions with companies, a set of 57 existing PSSs and PSS concepts (smart and traditional) was created. To keep the

classification task manageable for the participants, the initial set of PSS examples was reduced by focusing only on PSSs that are commercially available in order to increase the study's realism. Furthermore, PSSs that provided similar benefits to consumers were eliminated, which resulted in a final set of 29 Smart and traditional PSSs. The selected PSSs differed considerably in the balance between product and service, the purpose of the offering, and the situations in which they were used (see Appendix A). Moreover, examples of traditional PSSs that are often mentioned in the literature were included in the final list, with the purpose of obtaining insights in the differences between smart and non-smart PSS that are important for the user experience. A pilot test demonstrated that although the classification task was manageable, further extending the number of stimuli would make the interview tedious and fatiguing for the participants.

The development of the final stimuli consisted of different phases. First, a storyboard for each PSS was created. In order to create the individual storyboards, the main researcher diagrammed the process followed by consumers in each PSS, from purchase to use, depicting the main product and all service interactions. This resulted in 29 different product-service-user interaction diagrams, which were subsequently discussed with a professional interaction designer, in order to enhance their completeness. Then, the 29 individual storyboards were sketched by a graphic designer making use of professional software. The final storyboards were included in a booklet that was used as sensitizing material. Participants studied all PSSs prior to the classification task (see Figure 3.1). The booklet contained: an image of the

Figure 3.1 Example of two pages in sensitizing booklet used in Study #1-a

PSS taken from the official website, an extensive description of the product and the service in the PSS and how they interrelated, the storyboard, and a notes-section for participants to write comments or questions to be addressed prior to the session. " Together, the image of the PSS, the description of product/service elements in the PSS, and the story board, had the purpose of proving participants with an understanding of overall value proposition, and how product and service element interrelate in the interaction with consumers." Finally, individual cards showing each PSS at a glance were made to facilitate the classification task. The individual cards contained the name and picture (as shown in the booklet) of the PSS, and the storyboard.

Procedure

We contacted participants two weeks before the classification task. A booklet was provided to each individual, which they were encouraged to read at their own time and pace. Before the task started, the interviewer answered any remaining questions regarding each PSS. Furthermore, participants received instructions on the procedure, including a classification example, to ensure their understanding of the task.

Individual cards were randomized and placed on the table facing up to give an overview of the total set of PSSs. Participants were instructed to take two cards and to group them in one or two groups, based on perceived similarities. We asked participants to think aloud to reveal the rationale behind their classification choices. Once a first set of two cards was classified, participants continued with the remaining cards. Participants took one card at the time, adding them to the already created groups or creating new ones. This procedure was repeated until the entire set of 29 cards was discussed and classified (Figure 3.2). Subsequently, participants labeled every distinctive group using a name describing their classification criteria. Throughout the process of classifying and labeling stimuli, participants were instructed to group stimuli on aspects related to the user interaction and/or experience. Some examples of grouping labels used by participants include "measuring and keeping track", "feeling in control", "personalize it to fit your daily life", "feedback product allows socializing", "rent and return" and "people-people interaction". Participants took 55-145 minutes to complete the task. All participants completed the task satisfactorily.

Data Processing

All interviews were recorded and fully transcribed. The data were analyzed using the software program Atlas.it. Because of the exploratory nature of Study #1, the data processing was inductive; it did not begin from a preconceived set of themes, and our findings emerged directly from the data that were collected (Thomas, 2006). Transcribed interviews were coded looking for patterns and interesting themes in the data. This process was followed interview by interview until no significant amount of codes was added to the list, resulting in an initial set of over 100 codes.

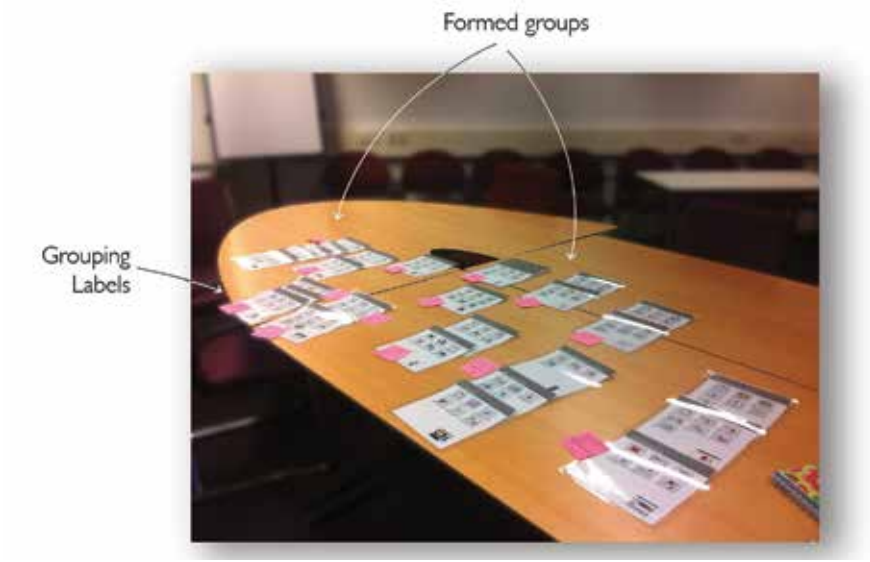

Figure 3.2 Example of classification task completed by a participant in Study #1-a

This set of codes was discussed with the main and secondary researchers, identifying codes with similar meanings, and main subjects in the data. For example, the codes "managing content" and "updating content/data" were merged into the code "controlling content", because of their similar implications for the experience of the end-user. Another example relates to the codes "feedback", "user feedback", "personalized feedback", and "product preview", which were merged into the code "type of feedback" because they explain the different ways in which information is presented to end-users. The process of merging similar codes allowed us to reduce the list to a total of 55 codes distributed among 15 themes. Identified themes related to different aspects, such as the smart product (e.g., data), the e-service (e.g., feedback), the benefits for the end-user (e.g., control), but also to aspects of how the Smart PSS is brought and implemented in the market place (e.g., business model). Once the list of codes was refined, the remaining interviews were transcribed. Additional codes were identified as overlapping with the existing ones, and classified in one of the identified themes. Even though the point of saturation had already been reached by the fifth interview, the remaining 11 interviews were coded in order to ensure that the full richness of the data was present in our findings. New characteristics were however not found. A final session with the research team was conducted to further discuss the resulting codes and to establish their relevance in relation to the research objective (Thomas, 2006). This concluding session lead to the selection of a set of 35 codes and 10 themes directly related to the characteristics of Smart PSSs. Finally, selected themes were further classified into six characteristics, which we will present below. Appendix B presents an overview of the final 35 codes and 10 themes related to our findings, as well as the relations between themes and characteristics.

3.1.2 Findings and Discussion Study #1-a

Study #1 led to the identification of six highly interrelated characteristics of Smart PSSs, based on the interaction and value in use for the consumer (Figure 3.3): *consumer empowerment, individualization of services, community feeling, service involvement, product ownership and individual/shared experience*. Importantly, some characteristics can be manipulated directly by designers, while others need to be discussed at a more strategic level (e.g., high management) to assure their correct implementation. Furthermore, the characteristics may vary in their dominance according to the context for which the Smart PSS is developed. Hence, the characteristics are not, by definition, present in all Smart PSSs. In this chapter, we present each characteristic and discuss the implications for designers.

Figure 3.3 Overview of characteristics identified in Study #1-a

Consumer Empowerment

Consumer empowerment is a characteristic of Smart PSSs that most participants recognized during the interviews. Designers saw empowerment as a characteristics of Smart PSSs, whereby consumers are assisted in making decisions or taking action on their own terms. We identified two main sources of empowerment in Smart PSSs: delivering feedback to consumers, and enabling consumers to select their own content.

Feedback is relevant information that consumers can use to assess a specific situation, and take action accordingly. Different features of Smart PSSs facilitate the delivery of feedback to consumers. First, Smart PSSs enable consumers to *measure their own data* at a specific moment in time. Because this information is usually stored online, this grants service providers access to relevant input on consumers' states and activities. By having access to data related to individual consumers, service providers can create personalized overviews of the measured data, thereby enabling consumers to *track their progress over time*. Furthermore, data are transformed into *graphs, diagrams and other pictorial representations* that consumers can understand easily. This type of feedback was often associated with Smart PSSs that facilitate the achievement of goals. For example, the WiFi Body Scale (http://www.withings.com) provides real-time feedback by displaying the weight and BMI of the consumer in the scale's screen when the Smart PSS is used (Figure 3.4). Furthermore, it provides

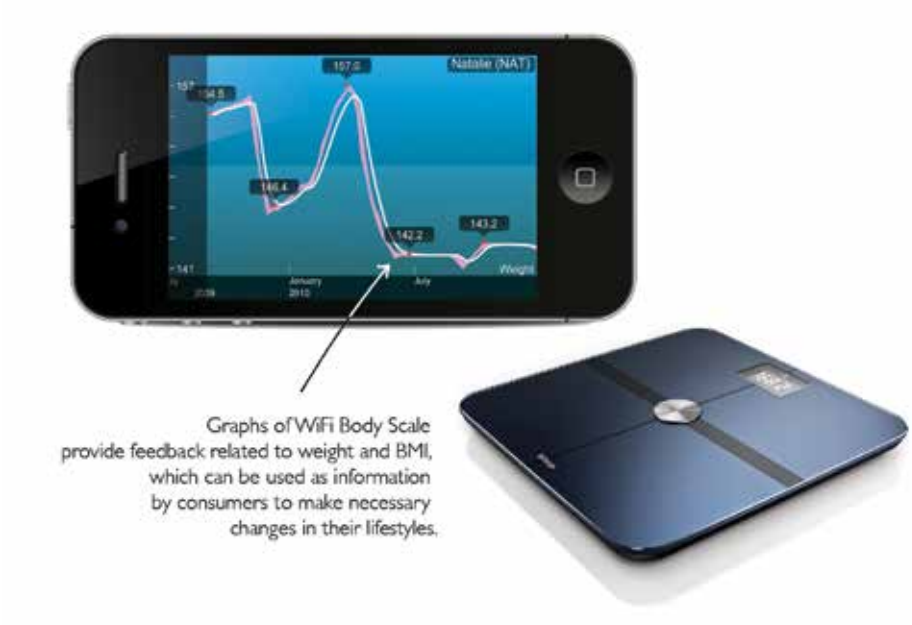

Figure 3.4 An example of feedback to consumers facilitated by WiFi Body Scale

long-term feedback by automatically sending these measurements to a web portal, which creates illustrative graphs of these over time. Together this information will empower consumers, because consumers who want to lose weight can use such feedback to understand how their eating habits affect the achievement of their goals. As expressed by one participant:

> "This is all about measuring, measuring and keeping track […] there is some aspect of life, like your movement, about pressure, or whatever, or something that for whatever reason is important for you. For example, with Fiat it's about not having a too big impact on the environment, and this one [WiFi Body Scale] has to do with health, […],you don't really need to do this unless you want to do it […]. And it's focusing on longer periods, […], but you can also look back at the data, it's really about the process of improving or not, and it's also really about the specific data, it's really qualitative information, it is really about understanding what is happening…"

Next to the capacity to track one's progress in a certain activity, Smart PSSs enable consumers to *track the status of products*, such as their availability and location. For example, Laundry View is a Smart PSS that enables consumers to check the availability of (specific) washing machines. Laundry View empowers consumers by helping them to take control over the process, for example, by visiting the laundry room only when a laundry machine is available:

> "Laundry view is about getting information on the moment you want it, without having to do all the walking, it's about easily obtaining short-term information, information that you need right now, it also makes life easier for you, you can plan more easily, you can set the alarm when the washing machine is available".

Smart PSSs provide feedback by *delivering relevant information regarding product features or content* prior to purchase. Such is the case with smart phones and app stores (e.g., iPhone and iTunes, http://www.apple.com), which provide descriptions, images and free trials of applications, but also enable consumers to give feedback to each other about the quality of the apps (see *Community Feeling*). Thus, this type of feedback empowers consumers by providing relevant information to make a purchase decision:

> "I think it's more about going online to see what exactly you want to have before you purchase or rent anything. So I think it's about online selection, there's a lot of information and options. There's way more than when you go to your shop on the corner of the street. Then it has maybe two types of Christmas trees or three and also with designer bags and stuff. They don't have everything and with the Laundry View it's also about, you get more information when you go online. I think

it's about online information and selection before purchase or rent".

Finally, Smart PSSs can empower consumers by enabling them to *select their own content*, and have an experience that fits closer to their individual needs. For example, Amazon's Kindle (https://kindle.amazon.com) is an e-book that consumers can use to read, buy and store e-books. Through the e-service in Kindle, the Kindle Store, consumers can browse and buy from a wide range of content, including e-books, e-magazines, e-news and games. Because of the wide range of options Kindle provides, consumers can select content that fits their individual taste or mood. Furthermore, enabling consumers to select their own content was associated with *service availability*; a service that can be accessed at any time and is always available to them:

> "Basically what the device does for you is that it allows you to download something. Then you can use it as you want [..] in the Kindle: you can look back and forward in the pages, so you always have an online database through which you can find information for you to use."

Design for empowerment is clearly a topic of interest for designers. The role of design practices, such as do-it-yourself (DIY) solutions and co-design, for giving consumers a sense of authority in the design of traditional products, has been previously discussed (Mugge et al., 2009; Wolf & McQuitty, 2011). Furthermore, it has been suggested that e-services and technology-based self-service options provide consumers with a sense of control (e.g., Dabholkar, 1996; Rust & Lemon, 2001). However, Smart PSSs offer innovative opportunities to combine these and thus the challenge for designers lies in this specific combination of e-services with tangible products, and how these new combinations create new ways to empower consumers. These ways of empowerment may, however, differ considerably across contexts. For example, a new parent may develop a sense of empowerment by having a Smart PSS whose smart product can be carried at all times while monitoring the baby's well-being, and an e-service supporting the well functioning of the device, and providing vital information to parents in case of emergency. In other cases, empowerment may call to developing an unobtrusive smart products and e-services that easily integrates with, and are operated as, other existing services and/or products consumers already use.

Consequently, facilitating empowerment in Smart PSS requires a deep understanding of the needs of consumers, and the role that both smart product and e-service can possibly play in consumers' lives. Moreover, designers ought to be aware of how the features enabling empowerment influence consumers' evaluations of the Smart PSSs' quality as a whole. This suggests a more wide-ranging role for designers, who could go beyond the traditional product-design related

manipulations. Furthermore, Past research has suggested that feeling in control of the process of service delivery has a positive effect in consumers' evaluations of such process and quality (Dabholkar, 1996). Although we presume that the above-mentioned features empower consumers, their effect on consumers' perceptions of control and consumers' attitudes is still unknown. Thus, further research is necessary to explore these interactions and to provide accurate advice to designers.

Individualization of Services

Participants recognized the individualization of services as a characteristic of Smart PSSs that can be implemented to make consumers feel important, by addressing them as unique individuals. The studied Smart PSSs individualize their services for consumers in different ways that are facilitated by the e-service. First, because of their digital nature, Smart PSSs make use of *user accounts to identify consumers*. E-services support the two-way communication between service providers and consumers (Lagrosen, 2005; Rust & Lemon, 2001). Through this communication, and by identifying consumers, service providers can collect specific data, and create more personalized solutions to satisfy their needs (Rust & Lemon, 2001). For example, Green Wheels (https://www.greenwheels.com) makes cars readily available to consumers, for specific periods of time, in a convenient way. Upon registration, consumers receive a personal e-card and pin code, which grants them access to the vehicles. Because Green Wheels has personal information about the consumers, such as their locations and demand, they can adjust they offer accordingly. Regarding to the effect of using personal accounts, and personalized services, a participant said:

> "Because the Green Wheels, of course it is not your own car, but it feels a bit like your own car I would say, because you have your own account, you have your own card, you can make your own reservation while the coffee machine and the multi-laundry room is just there and that you can use it is not personalized at all…".

Closely related to user accounts, Smart PSSs make use of *virtual servicescapes* to communicate with consumers. These virtual servicescapes are an important touch-point to implement tactics in the individualization of consumers. While some Smart PSSs make use of web portals accessed from computers, others allow consumers to access the virtual servicescapes directly through the product. Amazon's Kindle is a Smart PSS that provides both options (Figure 3.5). Consumers can access the Kindle Store to buy content directly through the e-reader, or access it through the Internet making use of a separate computer. Because consumers are identified with a personal user account that is needed to access the virtual servicescapes in both instances, purchased content is linked to the individual consumers, stored, and automatically synchronized through all virtual servicescapes. Furthermore, in many instances virtual Servicescapes are the sole means through which consumers communicate with providers, making it an important element to focus on in the design of Smart PSSs:

"That you buy a physical product, this is the first step, then you have to connect it with an Internet platform, then you have to use it for a certain time or not, just use it once. Then you [go] to the platform again and you update your personal profile and data you have, and then it gives you feedback on your progress on how well or bad you are doing. So it's a really typical product but then the experience after you use the product is really personalized".

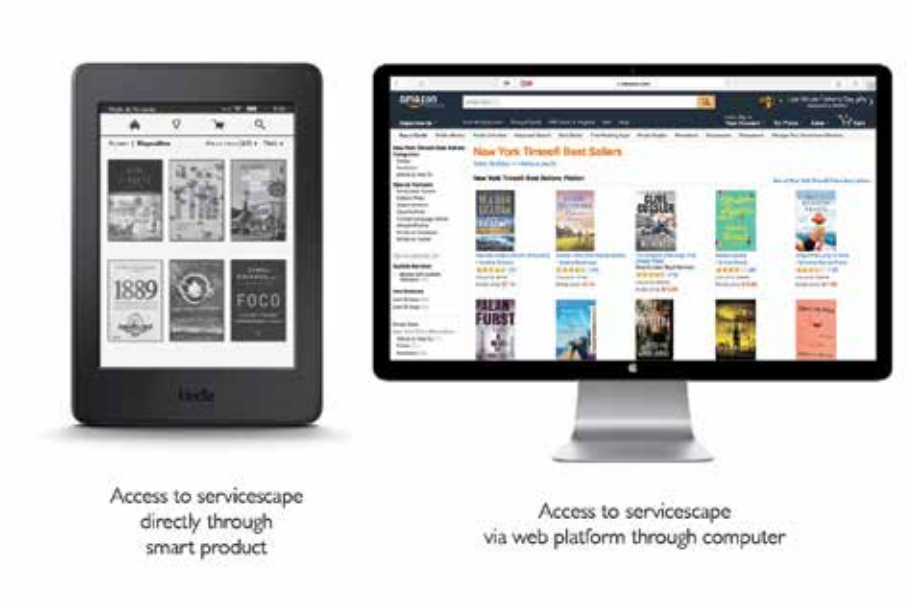

Figure 3.5 Example of virtual servicescapes. Amazon Kindle provides access to the servicecape through various platforms, for example, through the e-reader (i.e., smart product) and through computers (i.e., web portal)

Finally, Smart PSSs vary in the human-like interaction (Rijsdijk & Hultink, 2009), or *way of approaching consumers*, by the service provider. Some Smart PSSs make use of real people to interact with consumers. For example, Philips Lifeline (http://www.lifelinesys.com) is a Smart PSS for the elderly, which consumers can use in case of emergency. When consumers are in a life-threatening situation, they can press the button in the Life Line collar they wear, and an emergency call is automatically placed to a Philips representative. The Philips representative will then communicate with the consumer via an intercom, assess the situation, and send medical help when needed. Other Smart PSSs make use of artificial means (or automated responses) to communicate with consumers. For example, Nike+ is a Smart PSS that enables consumers to track their progress during running workouts. The product in Nike+ measures data, such as burned calories, distance and trajectory. The service in Nike+ (http://www.nikeplus.com) is a web platform that gives consumers access to graphs

and overviews of the data related to their workouts. Nike+ encourages consumers to exercise by awarding them with trophies and other achievement-related prizes. When consumers reach a goal (e.g., 10 kilometers running), they receive pre-recorded cheering messages from celebrity athletes. Thus, Nike+ communication towards consumers is automated, human-like, and linked to the specific development of individual consumers. The need to implement a more or less human-like interaction, depends on the goal and context of the Smart PSS. As expressed by one participant:

> "In these two products [Philips Lifeline and PT/INR Self Testing] you come into contact with a person. With the others you can exchange information with other people, but it's not something that you need or it's not an emergency. This [Philips Lifeline and PT/INR Self Testing] is something that you need [to be] attended by a person, and you feel like you want to be attended by a person. I don't feel that they would be as successful if, for example, with the Philips Lifeline you would have a platform. That would be impossible because you wouldn't be able to be attended as you need, so I think that is the main difference".

The implications of this characteristic (the human-like interaction) for consumers have been previously discussed by Secomandi (2012), who describes it as facilitating the development of relationship between consumers and providers. Similarly, Pinhaez (2009) highlighted the challenge for designers of creating automated yet human-like interactions for users of online services. The above-mentioned features are examples of how designers of Smart PSSs can individualize and 'humanize' e-services for consumers. However, these may not be the only tactics designers can implement to create a more personal experience with Smart PSSs. The integration of products with services poses great opportunities for designers. The perceptions towards the e-service can be greatly influenced by the tangible evidence (i.e., smart product and other touchpoints) that surrounds it (Bitner, 1992). Because the product in Smart PSSs is central to the consumer experience, designers have the opportunity to strengthen the individual value of the e-service through the physical characteristics of the smart product. In this respect, designers must have a good understanding of the message companies want to communicate to consumers. As will be discussed in Chapter 5, the integration of services and products with a congruent meaning can have a positive effect on consumers' attitudes towards the offering. Thus, the challenge for designers lies in strengthening the service through the tangible characteristics of the product while safeguarding the overall value of the Smart PSS offering. Consequently, creating individuality in the service through the product is a task for which other important stakeholders in the development of the Smart PSS should be involved; it is a task that requires the alignment from different functional areas to ensure that the correct value is communicated to consumers.

Community Feeling

Designers in the present study recognized Community feeling, or how Smart PSSs *facilitate the communication between consumers,* as an important characteristic of Smart PSSs. Said communication between consumers typically takes place through *social media*. Consumers give feedback to each other, share and exchange information regarding the Smart PSS. For example, Wattcher (https://www.wattcher.nl) is a Smart PSS developed to make consumers more aware of their energy consumption at home. The product in Wattcher is a sensor that measures and displays the consumed energy. The service is a web portal where consumers can store their measured data and track their development over time. An important feature of this web portal is an Internet forum that consumers can use to talk to each other, to compare measured data, and share advice on how to reach energy consumption goals (Figure 3.6). Other types of social media that are typically implemented in Smart PSSs

Figure 3.6 Example of community feeling. Wattcher promotes the community feeling in their platform by providing the means to consumers to compare measures and talk to each other

include the evaluative rating of content by consumers, *connecting and sharing of information* through social networks, such as Facebook, and the possibility of sharing information via email.

> "For example, for the Wattcher you can talk with other people that also use it and see how they are doing, so yeah".

> "I think the consumer experience of this, the Wattcher, is similar to the Nike+ and the Blood Pressure Monitor group, […], in the same sense that you can socialize through it".

Thus, through the use of social media, designers of Smart PSSs can enable consumers to share their opinions about, and personal experiences with the product and service. A good implementation of these communication channels could have significant implications for maintaining momentum in the use of Smart PSSs. Internet facilitates the rapid dissemination of word-of-mouth. Companies experience reduced control over the opinions of consumers, which could lead to negative repercussions for the adoption of market offerings. For example, the rapid dissemination of negative opinions by consumers, could result in a slow adoption of the market offering. However, by implementing social media as complement to their communication strategies, companies can engage consumers, communicate directly, provide targeted information, and shape and monitor their opinions (Mangold & Faulds, 2009). Thus, designers need to be aware of the important role that social media play in the adoption of Smart PSSs, and their relevance in bringing such services closer to consumers. Moreover, the implementation of social media in Smart PSSs may be an important expectation of consumers. Thus, future research could set out to define the instances in which these communication channels are desired, and how they create value for consumers (e.g., Is the communication expected to take place directly through the product? How does communicating through the product influence consumers' perceptions of the Smart PSS? Does it increase perceptions of empowerment?). Finally, because social media also supports two-way communication between consumers and service providers (as previously discussed), creating a feeling of community may be an important way of individualizing and bringing the service closer to consumers. How the product in the Smart PSS can be used to support this communication, and for which touchpoints in the provider-consumer interaction, are interesting avenues for future research.

Service Involvement

Service involvement refers to the nature of the relationship between consumer and service provider. As described in the preceding sections, Smart PSSs promote the *recurrent interaction* between providers and consumers. As with traditional

PSSs, designers saw this recurrent two-way interaction as facilitating the deeper understanding of consumers, prolonging the relationship between consumer and provider, and allowing the provision of more targeted solutions to consumers. For example, consumers of Kindle may access the Smart PSS several times in one month, reading and participating in user reviews, or simply buying Kindle content. Every time consumers access Kindle, Amazon can register, follow up their preferences, and learn from them.

However, in contrast to Smart PSSs, other types of PSSs (including those with lower or no content of IT technology) focus on particular stages of the consumer journey and involve fewer interactions between consumers and service providers. In tools sharing, for instance, consumers pay to make temporary use of professional tooling for gardening, construction, and other purposes (Mont, 2004). After being used, the tools are returned so other consumers can make sequential use of them. Thus, different to Smart PSSs, the interaction between service provider and consumers is virtually non-existent during the use of the product use, and between rental periods. Furthermore, because the product has no ICT in it, it does not connect the service to the product, making it more vulnerable to market replacements. Smart PSSs, on the contrary, have the unique potential to recurrently link product, service and consumers, which could translate into benefits for consumers (e.g., personalized solutions, prompt reaction to consumers' needs).

An often-mentioned way of promoting the recurrent interaction between the consumer and the service provider is the alternative of adding (e.g., downloading, buying) new content, which can renew the experience of consumers with the Smart PSS. For example, iMarker is a digital pen for children that functions in combinations with an application developed for iPad. With iMarker, consumers can select from a wide range of (digital) drawing, and choose from a variety of strokes and textures to draw. Because the application is updated periodically, consumers get access to new content (i.e., drawings), which keeps their interaction with the Smart PSS active:

> "Because it evolves, all those things evolve around a physical object which improves your life or something of your life, like driving or creative coloring for kids […] so if you like something and you can download more or if you are interested in specific animals to draw, you can probably download a whole lot of animals. And if you are interested in some kind of app then you can download a whole lot of them or improve those apps […] So the fact is that you actually don't buy a complete device in the first moment, although you pay the most for that, but later on you can actually buy little parts to improve that device".

For designers, it is important to understand the level of involvement that service providers aim to attain with their consumers, and vice versa. This understanding can be used as a framework in the developing Smart PSSs that support the correct level

of interaction. Having Smart PSSs that involve consumers extensively, but without the correct infrastructure to support it, may be detrimental for their adoption. Establishing an accurate level of involvement could lead to more congruent Smart PSSs, where product and service features are in balance.

Product Ownership

Product ownership, an aspect related to classification of PSSs based on business models discussed in Section 2.1.2, was also mentioned as an important characterizing aspect in the development of Smart PSS propositions. Consequently, our findings echo those of Baines et al. (2007), Tukker (2004) and others, by positioning the definition of the product ownership as an important aspect to be considered by designers, with potential important implications for consumers' experiences with the Smart PSS proposition.

First, the tangible product in the Smart PSS can be sold to consumers and its ownership transferred to them. In that case, consumers are responsible for the maintenance of the product. Maintenance includes installing software updates developed by the service provider, to guarantee the correct functionality of the Smart PSS. In Smart PSSs, consumers buy the product to gain access to and obtain value from the service. Owning the product grants consumers unlimited access to the PSS, unless restricted by other business-model related aspects, such as monthly fees to access the service. Examples of Smart PSSs where the ownership is transferred to consumers include Nike+, Wattcher and Kindle.

Second, the ownership of the product can be kept with the provider, who is responsible for maintenance and correct functionality of the products. In this case, consumers have limited access to the PSS, typically for specific periods of time. Different to those Smart PSSs where the ownership is transferred, consumers interact with service providers to gain access to the tangible products. Examples of Smart PSSs where the ownership is kept with the provider include Green Wheels and Laundry View.

> "Coffee Vending Machine, this is about having a big expensive machine which you rent, and which gives you what you want, and which is maintained by other people, which takes away some responsibility of your own and some risk …and it was similar to the Multi Laundry room where you also all share, it is supervised by someone else and they take care of it as well. It's very nice if you don't have the money to buy some for yourself".

> "So with the rental I will just put "rental" because I believe that they just rent things, that is different for the user because you give things back and that is yet another step and you don't own the product. It is also a different thing, if you own the products then you have to think of how to get rid of it as well".

Individual/Shared Experience

Individual/shared experience relates to the extent to which consumers' experiences with the Smart PSS are shared with other users. This characteristic can vary among Smart PSSs. For example, Direct Life is owned by consumers and used on an individual level. Although the system facilitates the communication between different consumers, the product as well as the service in Direct Life are used and experienced on an individual level. Differently, Nike+ encourages groups of friends, who all own Nike+, to compete with each other in reaching common goals (Figure 3.7). Their experiences are linked through the service, which connects consumers by depicting, for example, performance rates among competing friends. Because each consumer makes use of Nike+, the individual experience with the Smart PSS is maintained. However, the idea of goal sharing, and the simultaneous use of the Smart PSS, creates a shared experience between users of the Smart PSS. Finally, when talking about

Users of Nike+ can connect and compete with friends through the e-service to motivate each other.

Figure 3.7 Example of shared experience. Users of Nike+ can compare scores and compete with one another

shared experience, participants used words such as fun and games, suggesting "gamification", defined as the use of gaming elements in non-gaming contexts (Deterding, Dixon, Khaled, & Nacke, 2011, http://gamification.org), as an appropriate strategy to promote the shared experience among consumers. To exemplify the stated above, consider what a participant said about Poken and Sifteo

Cubes (https://www.sifteo.com), a Smart PSSs that allows consumers to play digital games in the physical world:

> "…I guess the fun part, the most fun part about it for me, it would be to share it with other people and the Sifteo Cubes is the same because you can also play games on your own with the interactivity and stuff, but I think it's most fun to play with other people, and Poken is not very much fun if you do it alone and it is about the sharing as well, sharing the activity or the information or whatever".

Other Smart PSSs are shared by different consumers, while the experience is devised as individual. For example, the cars of Green Wheels can be used by different consumers in a sequential manner. Although different consumers share the cars throughout the day, their experiences with the system remain individual. Differently, in Laundry View consumers share the laundry facilities with others, and their experiences (may be) greatly influenced by the interactions among them.

That designers recognized this to a characteristic of Smart PSSs suggest a level or awareness of the plausible impact of Smart PSSs on the social interactions of consumers (Creusen & Schoormans, 2005; Secomandi, 2012). Importantly, designers ought to be aware of the desired level of shared experience, because it may lead to important differences for the definition of Smart PSSs. For example, in designing shared experiences, designers may need to consider technical features that support the interconnection of the products (e.g., Nike+), or devise ways to control for environmental aspects likely to influence the individual, yet shared experience of consumers (e.g., the potential noise, messiness found at shared laundry facilities). Similarly, designers need to be aware of all the aspects surrounding the individual experience of products. For example, a product that is owned and experienced at an individual basis may require decisions on product aesthetics that are particularly focused on satisfying personal needs of consumers, such as the need to express their identity and/or associate themselves with social groups (Crilly, Moultrie, & Clarkson, 2004). Differently, designing experiences for shared Smart PSSs may require more general considerations on the aesthetics on the product, turning the focus of designers to creating uniqueness and individuality for the consumer via the service of the PSS.

3.1.3 Conclusion Study #1-a

Study #1-a has led to the identification of six characteristics of Smart PSSs. As may be evidenced in the large number of codes associated to consumer empowerment, this characteristic seems to play a particularly important role in the definition of Smart PSSs (from a designer's perspective), and in the creation of meaningful experiences/interactions for consumers. More generally, the identified characteristics can help designers to attain a better understanding of the possibilities, in terms of interactions

and experiences for consumers, emerging from the combinations of smart products and e-services. The analysis of a large set of PSSs helped to achieve depth in our descriptions of each characteristic. Consequently, our findings could guide the work of designers in the design of Smart PSSs, help them to define the experience they want to create around the system, and to make more informed decisions throughout the design process.

An important limitation of Study #1-a arises from the type of participants used in the study. Although participants had a background in industrial design, their experience with designing Smart PSSs was limited. Thus, Study #1-a, excludes the professional expertise of an actual Smart PSS design process, which can lead to the prioritization of specific characteristics, and the identification of new ones. To counter these limitations, we set out to validate our findings with Study #1-b, by discussing the characteristics we identified in Study #1-a with experienced professionals involved in the design of Smart PSSs.

3.2 Study #1-b

3.2.1 Method Study #1-b

Study #1-b was carried out with two objectives. First, to validate the findings in Study #1-a by checking their trustworthiness with experienced professionals (Thomas, 2006). Second, to obtain new knowledge from professionals involved in the design of Smart PSSs. In this chapter, we limit our reports to aspects related to the characteristics of Smart PSSs.

Interviews were conducted with 10 professionals from six different companies. Companies had different backgrounds and the Smart PSSs they developed were intended for different use contexts. Participants were contacted via research partners or personal contacts. Besides different types of designers (e.g., interaction designers, product designers, service designers), they included other professionals involved in the creation of Smart PSSs (e.g., problem owners; business owners or or idea owners, whose vision of the Smart PSS and market knowledge made them valuable contributors to the design process). This varied group of participants, with ample experience in design, helped to ensure the trustworthiness of the identified characteristics. Furthermore, it permitted us to make use of multiple new Smart PSS cases related to business-to-consumer solutions to reflect on the characteristics and/or identify new ones.

Procedure

In-depth, semi-structured interviews were conducted with all participants. To reflect on the characteristics, participants were asked to choose a specific Smart

PSS project they had contributed to. The interview guide was divided into two sections. After a short introduction about the purpose and content of the interview, participants were asked to describe the Smart PSS project they had chosen. It was important to have them describe the Smart PSS in their own words, objectively and without preconceptions of the characteristics to be discussed. The goal was to verify that the Smart PSS being discussed could be labeled as such and to create the opportunity to identify new characteristics to be added to the list. The last section addressed the characteristics of Smart PSSs identified in Study #1-a in a direct manner. Characteristics were introduced and discussed one-by-one. To guide the introduction of the characteristics, illustrative cards depicting keywords and examples of existing Smart PSSs were developed for each characteristic. Questions included: To what extent does this characteristic apply to the Smart PSS you developed? How important is this characteristic for the adoption of the Smart PSS? To answer these questions, participants primarily reflected on the Smart PSSs they had helped develop. The interviews concluded by asking participants about relevant characteristics/information missing in our list of characteristics. Interviews lasted between 50 and 105 minutes, which varied according to the time availability of respondents, and their level of detail while explicating concepts.

Data Processing

All interviews were recorded and fully transcribed. Interviews were analyzed making use of the software Atlas.ti. The data processing was both inductive and deductive. The analysis initiated from the characteristics identified in Study #1-a. However, we paid close attention to possible new concepts emerging from participants' explanations of the Smart PSS.

The data processing approach was as follows. First, a set of five interviews was fully coded by the main researcher, generating an initial set of 30 codes related to the characteristics of Smart PSSs. This initial set of codes was discussed with the other researchers, taking into account quotes of different participants to assure the correct interpretation of the data. Twenty-five codes were identified as directly related to any of the characteristics of Smart PSSs identified in Study #1-a. The remaining five codes (i.e., "continuous growth", "ecosystems", "evolution = not changing entire system", "gamification", and "clear roadmap of offering") led to the identification of an additional characteristic of Smart PSSs: *continuous growth*. Subsequently, the remaining five interviews were coded, adding three new codes to the list, which belonged to any of the already identified characteristics.

3.2.2 Findings and Discussion Study #1-b

The main objective was to validate the characteristics of Smart PSSs, as identified in Study #1-a. This objective was met satisfactorily. Each participant identified several characteristics as relevant to the Smart PSS project(s) he had contributed

to. Whether a characteristic was perceived as more relevant depended on the goal for which the Smart PSS was developed. These variations helped to validate our idea that the characteristics of Smart PSSs (as those of traditional PSSs, e.g., Morelli, 2002) are context dependent, and not necessarily generalizable across all types of Smart PSSs. This context dependency of the characteristics is exemplified by the following statement, in relation to a Smart PSS developed for the taxi market, which connects individual consumers with taxi drivers:

> " I don't see the goal for our consumers to communicate [i.e., community feeling] with each other and say, yesterday I had this great taxi, maybe tomorrow I will try this one. On the driver's side I see more of a community […] they are individual drivers and they can say, hey we work always together so give us a name and they can kind of create a virtual taxi company within our system […] So driver's side yes, so they can do their work better. Consumer's side no".

Some characteristics of Smart PSSs were acknowledged more prominently than others. In this regard, consumer empowerment, providing consumers with feedback and meaningful information, was perceived again as particularly important for creating value around the Smart PSSs. One participant had the following to say about empowerment, in relation to the Smart PSS he helped design, which was intended to help consumers to reduce their electricity consumption at home:

> "This is crucial. This is the core, you know?, it's giving you this information that before you couldn't have […] The information that people had was [available] once a year when they received the bill. It's impossible to change your behavior based on that, because it doesn't contain any information. Actually, it's just an amount of money. This doesn't give you any information that can help you think about: What can I do to lower this amount of money?".

Another characteristic often mentioned by participants was the individualization of services; approaching individual consumers through digital means in a meaningful and user-friendly way. This characteristic was considered relevant, because it can bring important challenges for the design process, such as the creation of high-quality interactions that positively influence the experience of consumers with a system.

Furthermore, participants considered service involvement, and in particular the recurrent interaction between providers and consumers, an important characteristic of Smart PSSs. To deepen this topic, we now proceed to introduce the seventh characteristic of Smart PSSs identified in Study #1-b (Figure 3.8).

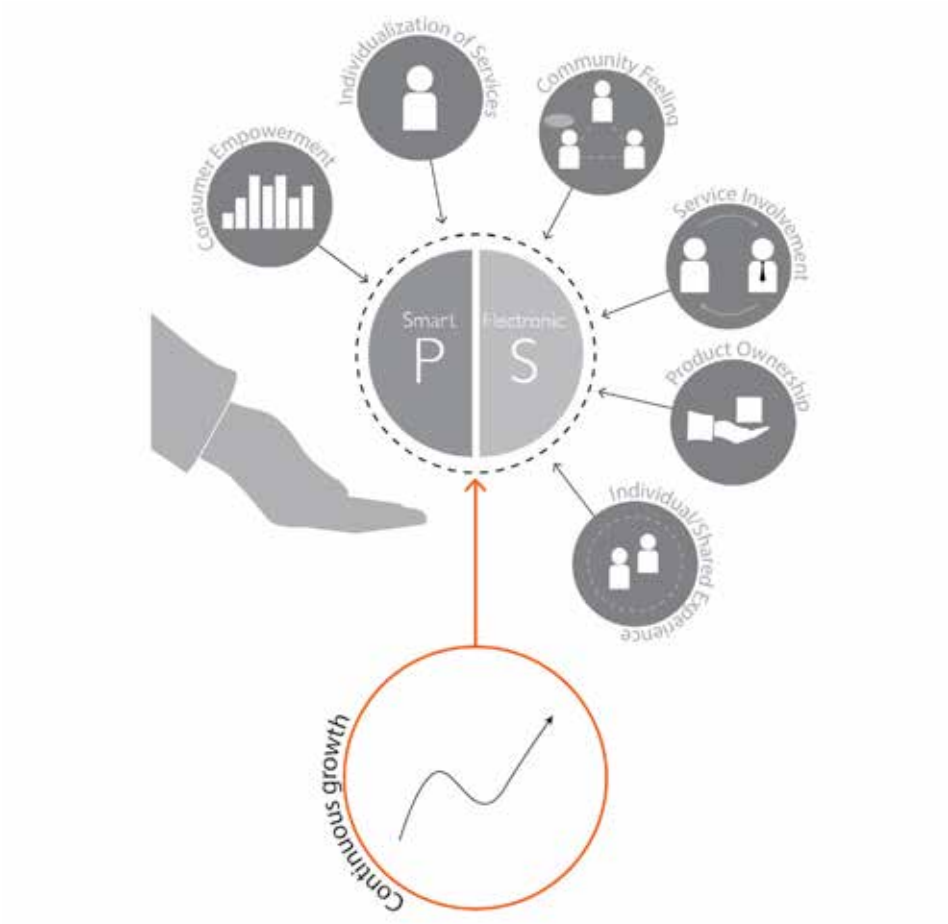

Figure 3.8 The seventh characteristic of Smart PSSs identified in Study #1-b: continuous growth

Continuous growth

Continuous growth relates to how Smart PSSs are in a *continuous state of development*, adapting or changing their value proposition over time. From a user experience perspective, the goal of implementing continuous growth (evolution) is to keep the market offering relevant, thereby maintaining their engagement (i.e., recurrent interaction) with the Smart PSS. Furthermore, by keeping the Smart PSS relevant for consumers, the perceived value of the system to the company can also be sustained over time. As explained by participants, digital technologies are developing fast and consumers are becoming comfortable around them. While consumers may place high value on a Smart PSS that is novel, such novelty may diminish over time as consumers' expectations of the Smart PSS change:

> "I have talked to a lot of people about it; for a while they kind of [perceived] it like they don't think it provides any more meaning or any more value to them, so they stop using it. So there is sort of a direct correlation between the meaning that it's providing for my life over time. So in the beginning there is a lot of meaning and then after a while it sort of goes down".

Different tactics were mentioned by designers as a way of leveraging the continuous growth of Smart PSSs. For example, to widen the offer of the system (and thus the options for consumers), companies can *periodically introduce new content or functionalities* via the e-service. Amazon's Kindle, for example, expands its content with the introduction of new content, such as books or games. Kindle has also grown by expanding the functionality of its product and software. In the early days of Kindle, it was only possible to read Kindle's e-books through a Kindle device. Nowadays, Kindle has expanded its functionality, allowing consumers to read e-books through multiple touchpoints, including PCs and mobile devices. Another tactic is the option to *open the system to other companies (or individuals)* who may want to implement services through the smart product. This is a tactic used by companies providing smartphones and other mobile devices, which allows independent developers to create applications to be distributed through their digital servicescapes (e.g., iTunes). Consequently, these companies have a wide range of new contents/functionalities available for their consumers, which facilitates the individualization of the Smart PSS, and answering to the changing needs of consumers over time. Finally, companies may also *open the system to consumers*, allowing them to co-create the system, thereby increasing their feelings of ownership towards the Smart PSSs. While in traditional PSSs co-creation is often discussed in relation to the interaction between service providers, suppliers and costumers, for example, through activities, such as workshops and meetings (Isaksson et al., 2009; Martinez et al., 2010; Morelli, 2006), in Smart PSSs the concept of co-creation is predominantly linked to facilitating empowerment, to enabling consumers to 'design' and 'manufacture' their own content/experiences, and providing them with the necessary means and tools to achieve their individual goals. Although the participants in Study #1-b had not developed a Smart PSS implementing this type of feature, some mentioned it as an important trend in the development of Smart PSSs. This interesting concept progresses the traditional views on ownership, by placing the value on the 'intangible' aspects of the Smart PSS.

> "I think that that's a common thing right now, maybe what will even go into the future, will be to add design skills in normal people so that they could get involved as a community in the design and manufacturing of their products and services […] And of course, manufacturers will stay manufacturers, and designers will still have their design expertise, but there will be a new design skill for anybody to also design and to also manufacture. And that will bring of course the community

feeling even more, and not only the community feeling but also the ownership of the products and services".

For designers, continuous growth may be a fundamental aspect of Smart PSSs, primary to creating long lasting relationships between service providers and consumers. As discussed, available technologies and market standards change fast, and consumers' expectations of Smart PSSs may change rapidly as they grow adapted to new technologies. Smart PSSs that do not address the needs and expectations of consumers may result on shorter lasting interactions between service providers and consumers. Thus, continuous growth can counter this possible issue by developing a system that adapts to its context.

3.3 Overall Discussion and Conclusion

The aim of Chapter 3 was to find more empirical evidence and a more specific answer to the following question: *What set of design characteristics can designers use while defining Smart PSS value propositions?* Our aim was to provide designers with new knowledge to aid the design of Smart PSS propositions. Particularly, our goal entailed the exploration and better understanding of Smart PSS design characteristics, with an emphasis on user experience/interactions (i.e., value in use), which can foster long lasting relationships between service providers and consumers. To achieve this, we set out to conduct two studies with young and experienced design professionals. These studies helped us to examine multiple Smart PSS cases and to capture the thoughtful reflections of design professionals around the characteristics of Smart PSSs. Accordingly, these studies led to the identification of seven characteristics of Smart PSSs, summarized in Table 3.1.

The characteristics of Smart PSSs outlined in this chapter provide a first overview of the opportunities for designers, in terms of value creation, based on the integration of smart products and e-services. Importantly, Smart PSSs promise to be an important means to empower consumers. The benefits of e-services in providing consumers a sense of control have been previously discussed (Meuter et al., 2000). However, when combined with smart products, designers (and companies) are presented with new opportunities to collect rich data about consumers, and to translate them into meaningful services (i.e., interactions and experiences) that are highly individualized, and which can elevate consumers' sense of control.

Similarly, such levels of individualization in the services can lead to important benefits for the design process. Market feedback received through the Smart PSSs enables companies to follow the changes in consumers' preferences closely. Companies have the opportunity to react/adapt more rapidly to the market, and stay relevant for longer periods of times. Furthermore, although Smart PSSs are not necessarily designed with eco-efficiency as the underlying goal, we see a

potential link between Smart PSSs and the eco-efficiency described in the traditional PSS literature. As Smart PSSs become highly individualized, consumers place less relevance on the tangible product, and give more value to the information/ digital content/services deriving from the system. Moreover, the characteristic of continuous growth favors the maximization of changes in the system through the e-service, potentially increasing the lifespan of the smart product.

Table 3.1 Summary of characteristics of Smart PSSs identified in Study #1-a and Study #1-b: definitions and examples

Characteristic	Description	Example
1. Consumer empowerment	Enabling consumers to make decisions or take action on their own terms. Enabled by: - Providing feedback (i.e., relevant information) to consumers. - Transforming data into information. - Information regarding product/ service status. - Information about product/service features prior to purchase. - Providing them with options.	Showing graphs that allow consumers to track development over time. Using time estimates to indicate availability and/or maps to show location. Product/service descriptions and/or user reviews. Implementing extensive libraries with content, which consumers can explore.
2. Individualization of services	Making consumers feel important by addressing them as unique individuals.	Identification of consumers. Use of digital servicescapes to communicate directly with consumers. Using a human-like 'tone' when communicating with consumers.
3. Community feeling	Facilitating the communication between consumers.	Enabling social media platforms, such as blogs, Facebook, or email to share content/information.
4. Individual/shared experience	Enabling a shared experience (with other consumers) through the Smart PSS.	Encouraging consumers to simultaneously use the Smart PSS (e.g., game) and share experiences.

(Continued...)

(...Continued)

Characteristic	Description	Example
5. Product ownership	Defining who is responsible for the product over time.	Rented product. Product owned by consumer. Product owned by consumer but shared with others (e.g., car pooling).
6. Service involvement	Facilitating/promoting the recurrent interaction between consumer and service provider.	Encouraging daily or weekly interaction with gaming strategies. Renewing the experience of consumers through content.
7. Continuous growth	Facilitating the growth/evolution of the system. Maintaining the Smart PSS and its perceived value relevant over time.	Introducing new content/ functionalities periodically. Opening the system to independent developers to create functionalities/services around the smart product. Providing tools to consumers to facilitate the development of their own content.

Despite the recognizable advantages deriving from the integration of smart product and e-service, designers ought to be cautious in the design of Smart PSSs. As with traditional PSSs (Martinez et al., 2010), Smart PSSs can be complex offerings, involving multiple and different types of users, touchpoints and use contexts. Consequently, the relevance of the outlined characteristics can vary considerably across contexts (Morelli, 2002). The effective implementation of the characteristics of Smart PSSs requires the thorough understanding of the user, the company and their context, in order to create Smart PSSs that are of value to individual consumers and organizations. In this regard, informal discussions with practitioners have indicated that the discussed characteristics could be used as a goal-setting tool, in terms of intended user experience, and to help communicate design goals among members of the design team. In combination with other design tools, such as customer journeys and written scenarios (see e.g., Polaine, Løvlie, L., & Reason, 2013; Stickdorn & Schneider, 2010; Van Boeijen, Daalhuizen, Zijlstra, & Van der Schoor, 2013), the characteristics of Smart PSSs could become a relevant tool in identifying the appropriate level of interaction to be implemented in the system. Furthermore,

the characteristics of Smart PSSs could be used to cross-check design goals with outcomes throughout the entire design process, and to better understand how such design goals change as the system grows. Finally, although the characteristics we identified are based on Smart PSSs, and intended for designers of Smart PSSs, we believe some may be transferable to other design contexts, such as the design of digital services and traditional PSSs adopting smart technologies.

Limitations

The studies conducted in this chapter have allowed us to identify several opportunities for designers in the creation of meaningful Smart PSS propositions. Furthermore, our results highlighted several potential challenges for designers arising from the integrative design of smart products and e-services, such as the achievement of coherence between the different elements in the system, and the adaptation of the Smart PSS value proposition to different users and contexts. However, while the finding presented in this chapter have started the conversation on possible relevant design challenges, they do not allow for a deep understanding of their root cause and relation to the Smart PSS design process. Going deeper in our understanding of Smart PSS design challenges is important to achieve a better understanding of the aspects influencing the Smart PSS design process and the development of meaningful Smart PSS value propositions. Consequently, Chapter 4 investigates the Smart PSS design process, its challenges, and implications for designers.

Moreover, the characteristics of Smart PSSs outlined in this chapter can be implemented at various levels of a spectrum (e.g., high vs. mid, vs. low community feeling), according to the context for which the Smart PSS is developed. However, further research is needed to explore how consumers react to Smart PSSs in different use contexts, and the perceived value they associate with the characteristics. This new information can help define the appropriate level of implementation for different scenarios, and help understand the role of the characteristics on the adoption and success of the Smart PSS. Furthermore, having this consumers' view can help fine-tune the characteristics of Smart PSSs, and help designers make more informed decisions during the design process. Chapter 5 aims at investigating how consumers react to Smart PSSs and to address the aforementioned concern.

Finally, because of the evolving nature of Smart PSSs, new characteristics may emerge in the future, which may be of relevance in the design of Smart PSSs. Thus, future research should aim to review the identified characteristics, and to assess them against emerging types of Smart PSSs. Such activity can lead to the inclusion of new characteristics, or the broadening of descriptions by, for instance, adding new examples on how characteristics can be implemented.

Image source: https://www.poken.com/press/

4. The Smart PSS design process[10]

10 This chapter is an adaptation of: Valencia, A., Mugge, R., Schoormans, J. P. L., and Schifferstein, H. N. J. (2014). Challenges in the design of Smart Product-Service Systems (PSSs): Experiences from Practitioners. *Proceedings of the 3rd Cambridge Academic Design Management Conference, Cambridge, United Kingdom.*

This chapter continues with our investigation of the aspects that can influence the design and definition of Smart PSS propositions. The research question in relation to the topic of 'the Smart PSS design process' has been stated as follows: *How can designers support the design process of Smart PSSs?* Thus, our aim is to attain a better understanding of the Smart PSS design process, and how designers, through their roles and their capacities, can contribute to the development of meaningful and value-lasting Smart PSSs.

Moreover, the chapter takes a particular interest on design challenges of Smart PSS design. The understanding of design challenges is important for different reasons. First, by understanding the challenges to be encountered in the design process, designers can more accurately identify the special design skills/capacities needed during particular design scenarios. Second, the identification of design challenges can lead to the selection of existing tools appropriate to tackle design challenges, or the creation of new ones for the integrative design of smart products and e-services. Finally, the identification of design challenges can facilitate the overall management of the Smart PSS design process, facilitating the implementation of relevant performance indications and other measurements, guiding the development of meaningful Smart PSS propositions.

An important conclusion from the literature review in Chapter 2 is that

design challenges are largely influenced by the elements of the design process, and that designers can make important contributions to help lessen such challenges. Consequently, in line with our conclusions of the literature review, the following three sub-questions guide our research effort through this chapter:

What are the elements of the Smart PSS design process?

What are challenges of Smart PSS design? And,

What are the designer role/contributions that help tackle design challenges?

Chapter 2 (Section 2.2) discussed the several elements of the (traditional) PSS design process, such as the consideration of a large number of touchpoints, and the evolved role of consumers and suppliers in the development of PSS propositions. Moreover, the chapter discussed the challenges arising in the transition towards PSSs, such as the required change in mindset of new PSS developers; and the potential contributions/roles of designers to help tackle the challenges of PSS design. While the literature review suggests a similar set of characteristics, challenges and roles of designers in the Smart PSS design process, we suspect the intrinsic characteristics of these solutions to play a role in how the design process unfolds. For instance, as most interactions with the service provider of a Smart PSS are of a digital nature, designers may be confronted with, for example, different considerations, and consequently different challenges than when designing face-to-face services or interactions with 'traditional' products. To illustrate, consider the characteristic of Smart PSSs of being in a *continuous state of development* (i.e., continuous growth, discussed in Chapter 3). Does this characteristic affect in any way the smart product and e-service that are designed? Does it affect the activities related to the definition of value propositions? Or the toolset designers use to aid the definition of value propositions?

Thus, the purpose of this chapter is to widen the existing knowledge on (Smart) PSS design, which can guide the development of accurate insights and guidelines for Smart PSS design. We achieve our purpose by means of Study #2; a single qualitative study that captures the experiences of design professionals in the design of Smart PSSs. The details of Study #2, its method, results and conclusions, are presented in the remaining of this chapter.

4.1 Method Study #2

We conducted semi-structured in-depth interviews with design professionals (N=10) from six companies in order to find answers to the three questions guiding our research efforts. Participants taking part of Study #2 were sampled following different criteria (Miles & Huberman, 1994; Patton, 2002).

First, we selected professionals with experience in the design of Smart PSSs, who could reflect on the challenges they encountered while designing Smart PSSs. Participants included designers (e.g., product designers, service designers, interaction designers) and other professionals involved in the creation of Smart PSSs (e.g., problem owners; proffessionals with a business perspective, whose vision of the Smart PSS and market knowledge made them valuable contributors to the design process). Second, it was important that participants could recall the specific of Smart PSS design processes they had taken part in. Consequently, we sought to interview participants whose involvement in the design of Smart PSSs had taken place in the recent past (i.e., no longer than 4 years), or was taking place at the time of the interview.

Furthermore, to increase the external validity of our study, we sought to interview design professionals from different companies (i.e., maximum variation sampling; Patton, 2002). The goal was to gain a broad perspective on the design of Smart PSSs; identifying elements of the design process, challenges and roles of designers that are common across companies and projects with different goals. To this end, we contacted both large and small companies, as well as design consultants and in-house designers. This varied group of participants helped to bring forward the perspectives from various professionals that are characteristic for the design of (Smart) PSSs (Isaksson et al., 2009).

With help of our industry partners, we developed an initial list of 11 potential projects (i.e., Smart PSSs) to be included in the research. Based on this list, we reached out to our professional network to identify and get in touch with potential participants. Next, the identified professionals were contacted by email (and when possible by phone) to explain the purpose and format of the research. This activity led to identification of the final 10 design professionals, from six different companies, who were willing to take part in our study (Table 4.1). All participants but two belonged to companies whose headquarters were located in the Netherlands. Two participants, working for a company that develops Smart PSSs for the events industry, were based in Switzerland.

Table 4.1 Overview of participants of Study #2

Interviewee	Role	Type of Company	Main Smart PSS discussed during interviews
#1	Designer (facilitator)	Design consultancy 1	Smart system to connect local communities
#2	Problem owner	Tools and technology for the taxi market	Smart PSS to help consumers and business operators (e.g., restaurants) to order taxis more easily

(Continued...)

(...Continued)

Interviewee	Role	Type of Company	Main Smart PSS discussed during interviews
#3	Designer (manager/ facilitator)	Tools and technology for the taxi market	Smart PSS to help consumers and business operators (e.g., restaurants) to order taxis more easily
#4	Senior product designer	Design consultancy 2	Smart electricity meter to help consumers gain insights into their electricity consumption
#5	Product design engineer	Design consultancy 2	Smart electricity meter to help consumers gain insights into their electricity consumption
#6	Problem owner	Tools and technology for the event industry	System that allows participants of events (e.g., fair-trades) to get in touch with each other
#7	Service/ Interaction designer	Tools and technology for the event industry	System that allows participants of events (e.g., fair-trades) to get in touch with each other
#8	Service/ Interaction designer	Design consultancy 3	Smart baby monitor
#9	Designer (manager/ facilitator)	Manufacturer of consumer products	Smart baby monitor
#10	Service/ Interaction designer	Manufacturer of consumer products	Smart baby monitor

Note: Due to confidentiality reasons, the names of the companies are not disclosed

4.1.1 Procedure

Semi-structured, in-depth interviews were conducted with all participants. This method of data collection was chosen over others, as it allowed researchers to capture the rich and individual experiences of participants, and enabled participants to express their opinions, judgments and ideas using their own words (Patton, 2002; Rubin & Rubin, 2002). This aspect was particularly relevant, as participants were asked to discuss potentially sensitive aspects of their work, such as moments were they encountered difficulties and how they resolved them. Furthermore, it allowed the researchers to inquire about other information that could help to understand the discussed issues, such as the background and history of the discussed projects.

Participants were contacted in advance to define the specific Smart PSS design project to be discussed during the interview. Nevertheless, during the interview, participants were free to make use of additional examples of design processes to help

them elaborate on the issues being discussed. An interview guide was developed to guide the interview while providing interviewees with the opportunity to address other, interesting topics (Patton, 2002). This interview guide was divided into four sections.

First, participants were given a short introduction on the purpose and content of the interview. In the second section, the participants were asked to describe the Smart PSS they had chosen. The goal was to ensure a common understanding of the Smart PSS being discussed, and to verify if the case being discussed could be categorized as a Smart PSS. All Smart PSSs that were discussed complied with our definition of Smart PSSs. The third section was directed at understanding how the design of the Smart PSS was organized, for example, in terms of the functional areas and stakeholders involved in the design process. This provided contextual information that facilitated the interpretation of the data during the analysis phase. The final section discussed in detail how the company dealt with the integration of smart products and e-services. This section took prominence in the interview and discussed the aspects central to our understanding of the Smart PSS design process. In particular, this section discussed the challenges that were faced during the design process, the tools that were used during the design of Smart PSSs, and the roles and contributions of designers during the design process. Together, the data collected in the third and fourth sections of the interview guide were aimed at obtaining a comprehensive view of the characteristics of the Smart PSS design process.

All participants were interviewed at their place of work, giving them the opportunity to develop/communicate their ideas through the use of readily available material, such as images and diagrams. Interviews lasted between 50 and 80 minutes. Participants openly discussed their experiences in designing Smart PSSs. Only one participant, who was an outsourced designer and bounded by a confidentiality agreement with his employer, had some restrictions on how openly he could speak about his design expertise. Although he refrained from disclosing sensitive information, he was still able to give his opinion in general terms. As a result, his input proved to be insightful and is included in this study.

4.1.2 Analysis

All interviews were recorded and transcribed verbatim, and analyzed by making use of the software Atlas.ti.

The analysis of the data was both inductive and deductive (Thomas, 2006). Our review of the literature on (traditional) PSS design provided us with useful knowledge, which structured the analysis and facilitated the identification of patterns and themes in the data (Miles & Huberman, 1994). However, our analysis maintained an exploratory character; the data was analyzed with no preconceived set of themes at hand, letting the findings on the Smart PSS design process emerge directly from the

interviews that were collected.

The coding process was as follows. First, a set of five interviews was fully coded by the main researcher, generating an initial set of 135 codes. This initial set of codes was then discussed with the researcher team, consulting quotes from different participants to ensure that the data had been correctly interpreted. During this discussion, codes were refined and merged, and an initial set of eight themes was established, which guided the further analysis of the data. The names of the themes are: characteristics of Smart PSSs (as discussed in Chapter 3), challenges (i.e., challenges of Smart PSS design), stakeholders, team, role of designers, goals for consumers, goals for companies, and tools.

Subsequently, the remaining five interviews were coded, adding new codes to the list when applicable. Twenty-five new codes were added to the list, all belonging to any of the already identified themes. Consequently, these 25 new codes were merged with existing codes, and categorized in one of the nine themes listed above. In a second session, all researchers reviewed the overall themes and codes once more, with the intention of finding subgroups and connection between them, as well as constructs. For example, 'stakeholders' and 'team' were identified as subthemes of 'design process', while 'roles of designers' and 'tools' are both related to how designers tackle the challenges of the design process. Furthermore, the previously identified themes of 'characteristics of Smart PSSs', 'goals for consumers' and 'goals for companies' were deemed to be closely related to the characteristics of Smart PSSs as reported in Chapter 3, and therefore excluded from the present analysis. The results of Study #2 are based on the concluding three themes, 'design process', challenges' and 'roles of designers', and their corresponding 56 codes. An overview of these codes, themes and constructs can be found in Appendix C.

4.2 Results Study #2

In this section, we address the overarching research question of this chapter: *How can designers support the design process of Smart PSSs?* To present our results by addressing each of the sub-questions presented in the introduction of this chapter. First, we describe the distinct elements of Smart PSS design, highlighting how these elements are similar to or different from traditional PSS design. Second, we outline challenges designers face in the design of Smart PSSs, while describing their relation to the distinct elements of the design process. Finally, we discuss five designer roles/ contributions that helped tackle design challenges in the Smart PSSs we studied.

4.2.1 Elements of Smart PSS Design

We found important similarities between Smart PSS design and traditional PSS design, but also distinct differences derived from the characteristics of Smart PSSs (Figure 4.1).

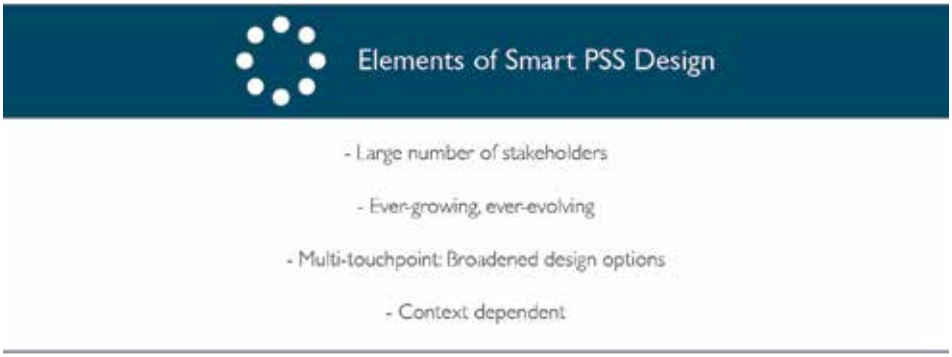

Figure 4.1 Elements of Smart PSS design

Similarities predominantly exist in aspects related to the organization of the design process. The development of Smart PSSs also requires the involvement of a *larger number of stakeholders* (i.e., development network), such as designers, manufacturing firms, technical experts, managers and end-users, than in traditional product design. This finding is in accordance with the traditional PSS design literature, where the importance of the development network is commonly acknowledged (e.g., Isaksson et al., 2009; Tan et al., 2010). The participation/relevance of stakeholders in Smart PSS design varies throughout the stages of the design process. This varying participation is also consistent with traditional PSS design, where the identification and organization of development networks, including partners, customers, suppliers, and sub-suppliers with complementary competencies, is necessary to realize the PSS (Isaksson et al., 2009).

> "… You really notice that, they wanted to hand over responsibility more to China, because the second user test had to be done there. So we wanted them to take more ownership of things, to prepare the second user test … So we had much less contact with the guy that was doing the technical side of the product, he was coming in now and then, but ... I was kind of wondering how it all would go well in the end. As I saw how last minute changes had to be made for our user test while we were all there." #8

Another similarity concerns the continuity of the design process. As discussed in Chapter 2, Isaksson et al. (2009) suggest that developers of PSSs need to be prepared for life-long development issues rather than thinking that the development process is over after product launch (p. 344). Although not specified by the authors, such development issues are likely to be related to the maintainability and reparability, aspects related to the serviceability of the product, which are characteristic of traditional PSSs in business-to-business markets. However, for Smart PSSs the continuity of the design process was discussed in relation to the *ever-growing, ev-*

er-evolving nature of the Smart PSS (as discussed in Section 3.3), and its link to the value proposition to consumers. The smart capabilities of the products in combination with the e-services offer companies the opportunity to continuously adapt their offer and value proposition. Developers can adapt the Smart PSS value proposition (e.g., content, designs, interactions) over time. For example, a Smart PSS developed to improve the health of end-users may periodically introduce new challenges and competitions to keep users motivated and engaged. Thus, the Smart PSS design process is also an ongoing activity, taking place for as long as the Smart PSS continues to evolve, and in continuous assessment of the value proposition and its value to users.

> "For me it would be growing the product, giving it more functionality and more diversity within the product. Being able to address a bigger market, the people that now don't use it because they cannot do their payment yet. We add payment and a new user group is added. Then I think we are going to be quite constant in improving what is there and making it more efficient than evolving." #2

Traditional PSSs and Smart PSSs are both complex types of market offerings, particularly because the integration of products and services results in a large number of touchpoints. As discussed in Chapter 2, some authors have emphasized that traditional PSSs require a larger number of company personnel to interact with customers while dealing with customer issues (Martinez et al., 2010). Consequently, the development of (traditional) multi-touchpoint PSSs may lead to specific activities, such as the training of employees at various levels of the organization to help them understand the language of customers (Baines et al., 2009). Differently, for Smart PSSs the emphasis is placed on the smart product(s) and digital interfaces facilitating the interactions of service providers with end-users. *Design options are broadened* due to the creation of *multiple touchpoints* that integrate smart product(s) and e-service(s) (Figure 4.2). For example, a Smart PSS may be composed of several smart products (e.g., wearable devices, smart phones, connected products) and several e-services (e.g., applications, web platform, in-device platform), all of which can be devised and provided to the consumer as one single offering in numerous ways.

> "We also have mobile apps and so on. So there are other elements we haven't spoken of that make it hugely complex. So it is infinitely more complex, it is very few start-ups create products like this." #6

> "…Of course this shifting might not be so much if you have as I said the product that is just one product, and you create kind of like customer experience enhancement by having an avatar, you know? It's a different thing. But if you make a smart city thing, or like, you know, then it becomes quite complex, or if the company becomes bigger or if you're actually, as I said, if you want to create this open, generic, smart solution, than uhh, then the possibilities are very overwhelming." #1

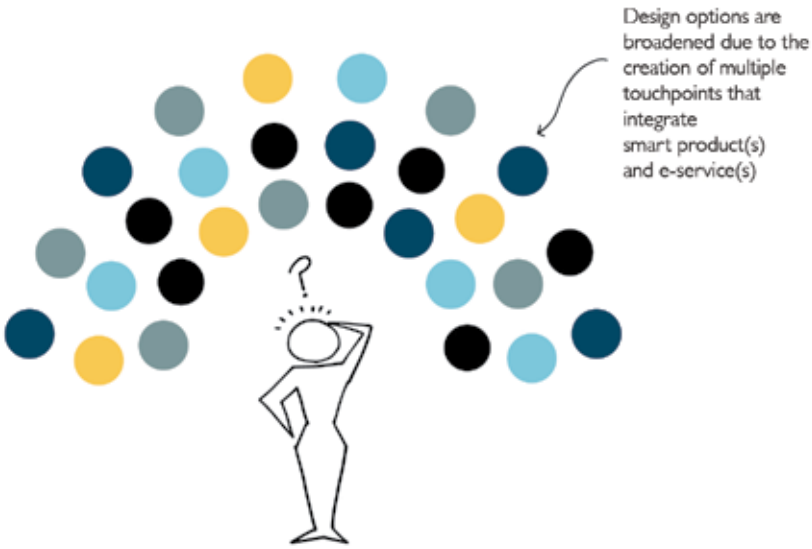

Figure 4.2 The broadened design options of Smart PSS design

Finally, the design of Smart PSSs, too, is highly *context dependent*. In traditional PSS design, context has been suggested to play an important role in the identification of stakeholders/actors, but also in the development of solutions that meet the specific needs of consumers (e.g., Tischner & Vezzoli, 2009; Vasantha et al., 2012). However, participants in the present study stressed the importance of context (i.e., market, type of user, end goal, etc.) particularly in relation to the definition of Smart PSS value propositions. Context dependency in Smart PSSs impacts the number or solutions a designer ought to consider to satisfy the varying needs of individual consumers. As discussed, designers are confronted with numerous design options and decisions when developing Smart PSSs. However, how Smart PSSs are conceived is highly influenced by the understanding of the use context and the desired experience for the end-user. Different contexts may lead to the identification of different needs, and, consequently, different requirements guiding the design process and solution.

> "We're always trying to look at it at what people want to do, rather than features. Because, you can solve it in so many ways, so it's all about what you want to accomplish… and then tech guys talk of features. But they turn eventually into features, right, these, these are needs." #3

> "It also depends on the stakeholder in the project. If you're Eneco, you don't want the consumers to change power company. Well, maybe [that they] change them

to you, but not the other way around. So it depends on who develops [the Smart PSS) and who are the stakeholders in, what would you want to have the product be able to do". #5

4.2.2 Challenges of Smart PSS Design

As discussed in the introduction to this chapter, we foresaw the elements of Smart PSS design to lead to specific challenges in the design process. The following section discusses the identified challenges of Smart PSSs, and their relation to the elements of the design process described in the preceding section. The challenges are linked to one or several of the elements of Smart PSS design, and are interconnected, as their root cause may be the same. The design challenges of Smart PSS design are (Figure 4.3): 1) defining the value proposition; 2) maintaining the value proposition over time; 3) creating high-quality interactions; 4) creating coherence in the Smart PSS; 5) stakeholder management; 6) the clear communication of design goals; and 7) the selection of means and tools in the design process.

Figure 4.3 Challenges of Smart PSS design

Defining the value proposition

The broadened design alternatives and context dependency of Smart PSSs call for a careful definition of the value proposition. Technologies in Smart PSSs facilitate the generation of multiple data (e.g., measurements, content; as discussed in Chapter 3), which are transformed into meaningful information through service interactions.

However, the alternatives for creating service interactions are innumerable and dependent on the context for which they are developed. Consumers derive different types of value from information/interactions according to their specific needs. For example, a Smart PSS designed to measure physical activity requires a different value proposition for end-users with a specific health issue (e.g., high cholesterol) than for those who wish to manage their weight. While the former may involve the intervention of health experts to support end-users in the interpretation and use of data, the latter may rely on an individual approach, where easy-to-understand information is key to empowering end-users and helping them reach their goals. Furthermore, e-services facilitate direct and frequent communication between companies and consumers (Rust & Kannan, 2003). Consequently, designers must carefully define the data and information provided to consumers through the e-services, carefully considering the relevance of interactions/data/information for the context (e.g., cultures, social needs, attitudes; Morelli, 2003) in which the Smart PSS is used.

> "Any artefact doesn't empower anyone. The empowerment comes through how someone interprets that. What their goals are related to the data." #10

Maintaining the value proposition over time

The ever-growing, ever-evolving nature of Smart PSSs represents opportunities and challenges for the design process. The opportunities lie in keeping the value proposition relevant through the service. Companies can periodically create new possibilities for consumers by introducing new interactions in the Smart PSSs. For example, Nike+ (www.nikeplus.com) has periodically introduced new functionalities to its platforms throughout the years, following the changing needs of consumers. One of Nike+'s latest introductions is a feature called 'Nike+ Coach', which offers different training programmes for runners at different levels (http://nikeinc.com/nike--3/news/nike-running-invites-more-runners-to-reach-their-training-goals). The manufacturing and start-up companies in this study perceived service design as demanding much shorter lead times and resources than product design (e.g., when compared to the resources needed to design and manufacture electronic products). Consequently, the recurrent development/introduction of new interactions in the Smart PSS was seen as a means to test its value proposition with consumers in a timely manner, making it possible to react to changes in the market (e.g., new needs) more rapidly.

> "We release product updates as often as possible and we try to have about a six-week product cycle or six-week release cycle […]. We build it and we test it and make it available […] every six weeks. We can say this [new feature] is good, but let us work on something completely different." #7

The challenge associated with the ever-growing, ever-evolving nature of Smart PSSs is to have a clear vision about where the market is heading in the long term, and the ability to adapt the value proposition as the market changes. This long-term vision relates not only to the expected changes in consumers' preferences (e.g., related to content or how the information is presented), but also to technological developments (e.g., leaving enough room in the design of the physical product to add new capabilities). Having this vision can lead to a better definition of development roadmaps, guiding the evolution of the Smart PSS. Furthermore, it can help anticipate the characteristics of the smart product (e.g., sensors) that are required to enable certain functionalities or features in the service. Consequently, the design of Smart PSSs can benefit from the involvement of professionals with high awareness and understanding of market trends, whose input can help manage the design process, for example, by defining the development steps guiding the growth of the Smart PSS.

> "You just have to kind of create enough degrees of freedom [in the product] to be able to get what you want in the [service]…" #4

Creating high-quality interactions

High-quality interactions refer to the human dimension of Smart PSSs. Because Smart PSSs often minimize the face-to-face interaction between provider and end-user, designers ought to be empathic about the emotions evoked through the Smart PSS and the overall experience created around it.

> "It was challenging, but the reason we have won the market and killed our competitors is that they didn't understand the fundamental emotional aspect […] we really understand the emotional aspect of what makes it a success." #6

Designers face a challenge in translating end-user needs and wishes into meaningful, high-quality interactions due to two reasons. First, the broadened design options provide an overwhelming set of opportunities. Designers can more easily lose sight of design goals, which can lead to inaccurate service interactions. Second, the ever-evolving nature of Smart PSSs means that from time to time there might be changes in not only the product/service offering (e.g., product functionality/content), but also the interaction between end-user and the system. Thus, designers face a challenge in maintaining high-quality interactions as the system and its user evolve (Figure 4.4). The quote below exemplifies the view of one participant on the quality of interaction, particularly in terms of the relevance of meaningful information. The participant highlights the importance of understanding user needs, and the impact it can have on the recurrent interaction with the system:

> "People are not loyal … you have to offer them what they want and they are loyal … offer them the information they want once they open it." #2

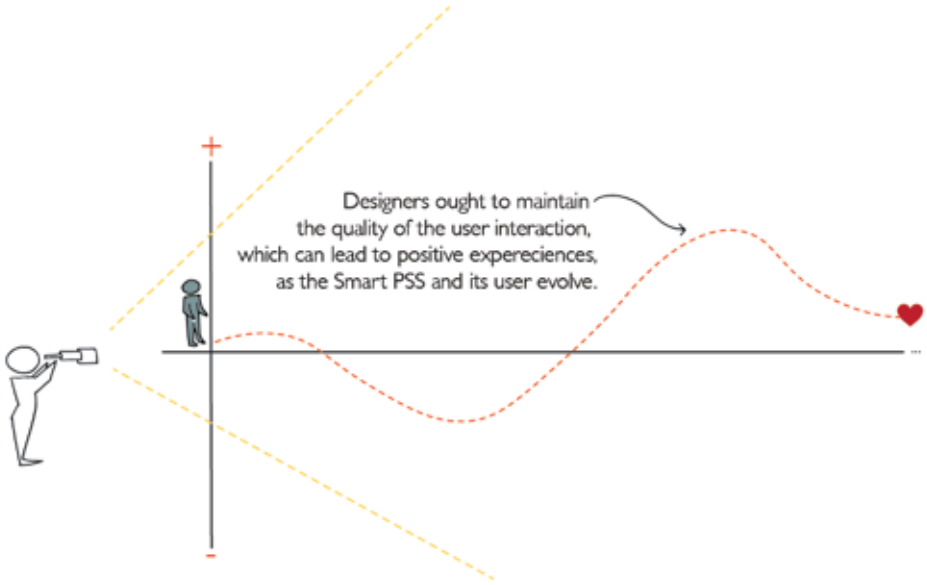

Figure 4.4 The challenges of maintaining high quality interactions over time

An important side effect of creating high-quality interactions is the positive effect it has the experiences of users and the development of trust. The concept of *Trust* and its relevance for online transactions have been previously demonstrated (see e.g., Gefen & Straub, 2003; Harris & Goode, 2010). For example, Harris and Goode (2010) highlight the perceived aesthetic appeal, functionality and security of an online transaction as influencers of the trust and loyalty associated with the e-service. In the case of Smart PSSs, trust may relate to the technology being used (i.e., new functionality in the product), but also to the way data are handled through the Smart PSS. As some personal data are considered sensitive, interactions with the Smart PSS should assure end-users that the providers engage in correct (ethical) data management. Furthermore, trust is enhanced when the interactions/ information provided by the Smart PSSs match the expectations of end-users. As exemplified by one participant, in relation to a Smart PSS developed for parents to monitor the sleep and sleeping environment of their baby:

> "A lot of parents also said to us, don't take over my intuition, I am the parent. So there is a delicate, delicate balance there, you know. I don't want [a] machine or iPhone to tell me [what] I am, or what I should do as a parent. Just give me hints." #9

Creating coherence in the Smart PSS

The multi-touch nature of Smart PSSs adds complexity to the design process and complicates the achievement of coherence within the Smart PSS. Coherence between touchpoints is important because it can influence consumers' overall experiences of the system (Sangiorgi, 2009; Shostack, 1982). We found evidence for two types of coherence.

First, we identified visual coherence, defined as the cohesiveness between the visual representations surrounding the Smart PSS, such as colors, shapes, images or written language (van Rompay, de Vries, & van Venrooij, 2010). Visual coherence is important because it can help consumers associate different touchpoints as belonging to the same Smart PSS (or group of Smart PSSs). Second, we identified coherence of interaction, which is defined as the behavior of the system across touchpoints (e.g., gestures in the system) and how it communicates with end-users. Despite the ever-evolving nature of Smart PSSs, the interaction with the system should remain consistent across touchpoints over time, minimizing the effort invested by consumers in learning how to use it.

> "[Coherence] makes sense [because] you create one experience for the user, but also [because] you help the user to use it more easily, you know. Like he doesn't have to relearn how to use the service." #3

Stakeholder management

Designers face a challenge in the management of stakeholders due to the (larger) transdisciplinarity of the design process of Smart PSSs. As discussed in Section 4.3.1, multiple stakeholders are involved with different perspectives on what the system should deliver, and with different problem-solving approaches or jargon (Dougherty, 1992; Martinez et al., 2010), which may hinder communication and cooperation between stakeholders (Kleinsmann & Valkenburg, 2008). For example, an entrepreneur may have a daring attitude towards product development and may rely on fast product launches to assess the reactions of consumers with the Smart PSS and adapt its value proposition. However, some investors may be cautious and unprepared to these short iterations, aspiring to longer development cycles, fully developed products, and certainty on consumers' reactions before the Smart PSS is launched. Thus, designers face the challenge of integrating stakeholders' demands, finding common ground in design/development approaches, and getting commitment from all parties. Furthermore, due to the ever-evolving nature of Smart PSSs, and different degrees of stakeholders' involvement throughout the development process, design managers face the challenge of clearly communicating the role/contribution of the different stakeholders throughout the design process.

> "It opens up a whole new world, a whole new box of stakeholders that need to be involved ...And a lot of these stakeholders, especially these product developers … are not used to being exposed to the methodologies that we use in, for example, digital methods. So we have technological people, business people, engineers, who aren't necessarily aware of the way we designers do things." #10

Differences between stakeholders were perceived to have positive consequences on the design process and outcome at times. Discussions on the Smart PSS helped to identify the need to bring in new parties. Furthermore, differences were perceived to raise the quality of the final solution. Thus, a challenge arises in managing the discussions between stakeholders, and sustaining the positive effect of clashes on the design process.

> "We went through many iterations that were not quite right. And the people that helped create [the] iteration felt like it was right. I was the one that was pushing back. So [by] picking and having different people involved in different stages, but all during the design process, [we] came up with this [solution]." #6

Clear communication of design goals

The communication of design goals among stakeholders is challenging for two reasons. First, the multiple elements making up part of the system (i.e., products, e-services, other touchpoints) may complicate the communication of the Smart PSS value propositions, and the depiction of connections and relations between its elements. For example, some Smart PSSs have different use contexts, with different products and services in each of them. Thus, the information depicted through the service may vary considerably among contexts, complicating the communication of the system as a whole. The visualization of the Smart PSS was mentioned as a particular challenge to the communication of design goals. Because visual representations aid in the discussions around design goals (Valencia et al., 2013), this challenge may hinder effective communication among stakeholders in the design process.

Second, while designing Smart PSSs, designers undergo cognitive shifts; they need to attain a picture of the whole system (i.e., different elements, actors, regulations, information, etc.) and an understanding of the specifics that facilitate the development of meaningful user interactions (e.g., characteristics and features in the e-service). These cognitive shifts often occur while discussing the Smart PSS with other stakeholders and aligning design targets. Thus, these cognitive leaps may be required not only from designers, but also from other stakeholders in the development process. However, making such cognitive leaps may pose difficult to some members of the design team than others (Figure 4.5), which can affect the effective discussion and the shared understanding of design goals.

"Even in my mind, I had to cut out a whole part of it and cut it out even to the team; just have the team focus on one little piece. The product was being developed in the wrong direction. I had to say, forget all that and focus only on this […] you have to start very simple." #6

"It would be super useful for to me to have an example, to have this kind of mapping out of the whole system, to make sure that I don't forget something. Because that I think is one of the challenges, the pitfalls that you just completely forget about a certain aspect of the system. Because it has so many touchpoints and things you have to think of. So otherwise a whole data stream may be lost somewhere. You might not think of how information got from somewhere or how you send something back… So, it's definitely going to be complex."#10

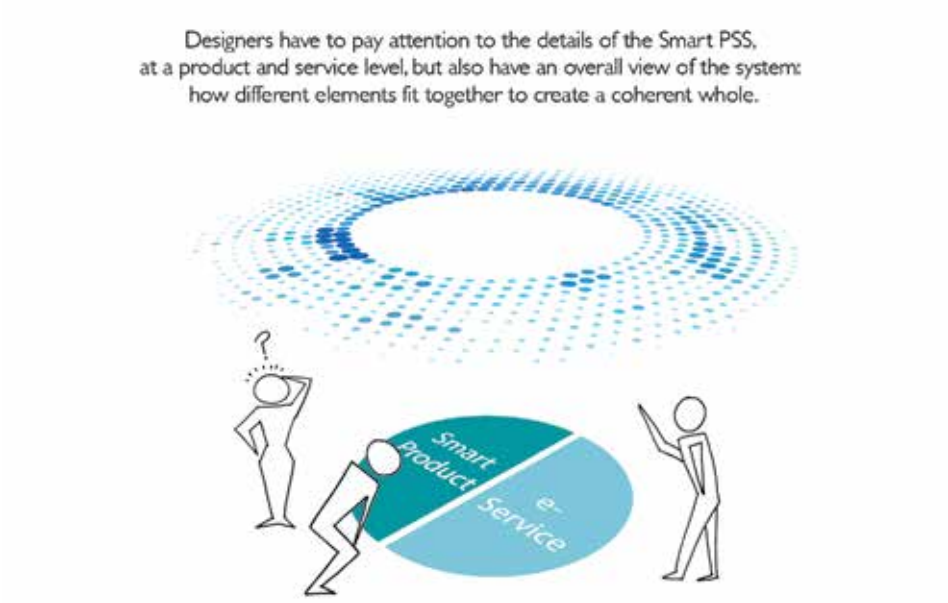

Figure 4.5 The cognitive shifts required in Smart PSS design. Designers require an understanding of the system as a whole as well as the specifics that facilitate the development of meaningful user interactions

Selection of means and tools in the design process

Smart PSS design is considered a new and evolving area of expertise. Designers largely work by trial and error, and the use of traditional product/service design tools (e.g., prototypes, illustrations, scenarios) is predominant. All of our participants were experienced designers. However, none was particularly trained in the

design of Smart PSSs, and the 'newness' of the field posed challenges when selecting tools and methods to support the design process. Existing product/service design tools had been adapted by designers to the new integrative design of products and services. Yet, participants expressed uncertainty about the effectiveness of some tools, and required a change in mind-set when combining products and services.

> "Not many people have experience with this. And especially getting kind of all these disciplines together, figuring it all out, trying to do the best for [the company], but nobody really has experience, that's a challenge in itself." #9

4.2.3 Designer roles/contributions that help tackle design challenges

As discussed in Chapter 2, literature in design management has long discussed the roles and contributions of designers in the development of products and services. Furthermore, the work of Morelli (e.g., 2003, 2006, 2009) has been particularly important in understanding the design skills and tools that can contribute to the effective development of PSSs. Consequently, rather than disputing the existing valuable literature, our goal is to explore the skills and tools that are called for in the design of Smart PSSs in connection to design challenges; the roles and contributions of designers and the instances when they become relevant. We found evidence for five roles/contributions of designers to the Smart PSS design process (Figure 4.6): 1) designers as *guardians of user experiences*; 2) as *foreseers of future scenarios*; 3) as *integrators of stakeholders' needs*; 4) as *problem solvers*; and 5) as *visualizers of goals*.

Figure 4.6 Overview of findings: roles/contribution of designers

Designers were acknowledged to play an important role in *guarding the user experience* around the Smart PSS (Valencia et al., 2013). This role is similar and associated to that reported by Morelli (2002) of investigation of the needs, motivations and barriers for adoption of PSSs. Designers have been trained to think in a user-centred manner. They have been equipped with tools to understand the context of the end-user and their needs towards the system. To this end, designers perform a series of activities traditional for their practice. For example, by prototyping the product and service, designers can evaluate and discuss the concept first hand with end-users (and stakeholders)(Blomkvist & Holmlid, 2010), validate it, and achieve a better understanding of its coherence and perceived value (Steen, Manschot, & de Koning, 2011; Valencia et al., 2013). The quote below illustrates the role a problem owner saw in design in relation to the experience of users. The problem owner acts as a designer himself (Gorb & Dumas, 1987), but relies on design to create high-quality interactions in the system and foster empathy with the users:

> "Once we designed [the Smart PSS] in kind of squares and points, we sat down with designers and talked about the feeling it should have and [the] trust [the Smart PSS should convey]. They would start designing around it, and those [aspects] are really important." #2

Companies providing Smart PSSs seek to create long-lasting interactions with end-users. To this end, designers were acknowledged to be *foreseers of future scenarios* who help shape and maintain the value proposition over time. Valencia et al. (2013) identify a similar set of roles, with a focus on the monitoring and dissemination of relevant information among stakeholders, such as information about competitors, design and societal trends. In contrast, participants in the present study credited designers with bringing tools to the design process that can aid the design of Smart PSSs in the long term. Echoing the research of Morelli (2009), scenario thinking was particularly acknowledged as an important tool in the design process because it helps foresee (changing) end-user preferences and technologies (Sanders & Stappers, 2008) or the development roadmap needed (and actors involved) to reach a particular end. The example below illustrates the value of scenario thinking for the design process. In this particular case, designers used scenarios to foresee aspects related to the product and service, and, importantly, to have a better perspective on the different users and needs towards the system:

> "But the issue was that we had to think [of] the future of all the possible services; first was to really think in advance of the possible services that the connected [Smart PSS] could bring, and at the same time, understand what kind of features and functionalities such a thing could have […] in industrial design, or how we used to do it, you have a user-centered design, but there could be so many [users]… So, where do you put your focus on?" #1

Designers were perceived to play a role in integrating stakeholders' needs (Morelli, 2002; Valencia et al., 2013). Participants highlighted the importance of a project champion, someone with an overall view of the system and a clear understanding of what the project should deliver. This project champion was associated with the role of the problem owner (i.e., a design thinker), but also with designers themselves. Furthermore, some designers saw this as a central contribution to the design process, even when not purposely assigned. For example, one of the design consultants interviewed described their role in the design of Smart PSSs as follows:

> "[Our role], and I think that's our specialty, is integrating all the stakeholders' demands. And we didn't give it that actual name [to the role], but it was more the way the project evolved, and how our role evolved within the project. And obviously [company name] was still our client, but we had to do with a lot of partners, that all had their own stakes within the project. And we made sure we integrated all the, basically, the stakes of all the stakeholders." #4

Furthermore, designers contributed to generating interesting discussions that led to important solutions or decisions. Designers were perceived to be *problem solvers*, capable of dealing with abstract and complex information related to the Smart PSS (Sanders & Stappers, 2008; Valencia et al., 2013). As discussed in Chapter 2, Morelli (Morelli, 2003) describes the PSS designer as 'agent of the selection process' and as a synthesizer of 'different concurrent perspectives' (p.76). We view this role much in line with the Smart PSS designer as a problem solver. Specifically, asking questions during development meetings, bringing forward solutions and listening to stakeholders' opinions were perceived to have a positive impact on the final solution (Sanders & Stappers, 2008). This can help organizations to define the intended purpose and value of the innovation being implemented (De Lille, Roscam Abbing, & Kleinsmann, 2012; Kimbell, 2011).

> "And what we notice often: that direct communication doesn't work. People who design the electronics think in a different way than the consumer does. So, basically we were some kind of translator between different worlds and different stakeholders, and keeping constantly all stakes." #5

Similarly, supporting the research of Morelli (2009), designers were credited as *visualizers of project goals*; their visualization skills are key in translating abstract information into more tangible means. The role of visualizations in the Smart PSS design process is discussed by Secomandi (2012), who highlights the impact visualizations have in getting to more accurate design goals, but also in the communication within the design team and clients. In our study, we found similar evidence of the role that designers' visualization plays in the Smart PSS design process, particularly in communication among different stakeholders (e.g., De Lille et

al., 2012; Krucken & Meroni, 2006; Valencia et al., 2013). Design tools typically used in both product and service design, such as storyboards, drawings, and prototypes, helped to attain a better visualization of the Smart PSS. They contributed to a shared understanding of the project objectives among team members, for example, when they were used to discuss project goals during project meetings.

> "If you have a product described on paper, people won't really understand it. With visuals they can create a storyboard and it can be just going from page to page, and then describing the story to the people, and they will understand, and [this] makes it come alive." #7

4.3 Overall Discussion and Conclusion Study #2

The aim of this chapter was to attain a better understanding of the Smart PSS design process and its implications for designers. We have addressed our research aim by investigating three specific questions: What are the elements of the Smart PSS design process? What are the challenges of Smart PSS design? And, what are the designer roles/contributions that help tackle design challenges? Our findings and answers to these questions are summarized in Figure 4.7.

Our findings demonstrate similarities and differences between traditional PSS design and Smart PSS design. In particular, the involvement of a large set of stakeholders seems to be a common aspect. However, there are also distinct differences that evoke particular challenges in the Smart PSSs design process, rooted in the specific combination of smart products and e-services.

Challenges of Smart PSS design are predominantly the result of the broadened design options for designers. The multi-touch nature of Smart PSSs can complicate the visualization of the value proposition, thereby affecting the clear communication of design goals among stakeholders and the effective progression of the design process. Furthermore, as companies try to keep their solutions relevant over time, they add new features and functionalities to products and e-services. These two elements combined (i.e., the multi-touch and ever-growing nature of Smart PSSs) bring a large degree of freedom and dynamism to the design process that can be overwhelming for designers, and affect the clarity and quality of the value proposition. Moreover, as companies work towards 'systems of systems' (i.e., families of Smart PSSs that are connected through their technology and services, Porter & Heppelmann, 2014), designers face an increasing challenge in maintaining coherence (e.g., concerning ease of use, identity, value) in the user experience, as well as communicating the value proposition of these 'systems of systems' during the development process.

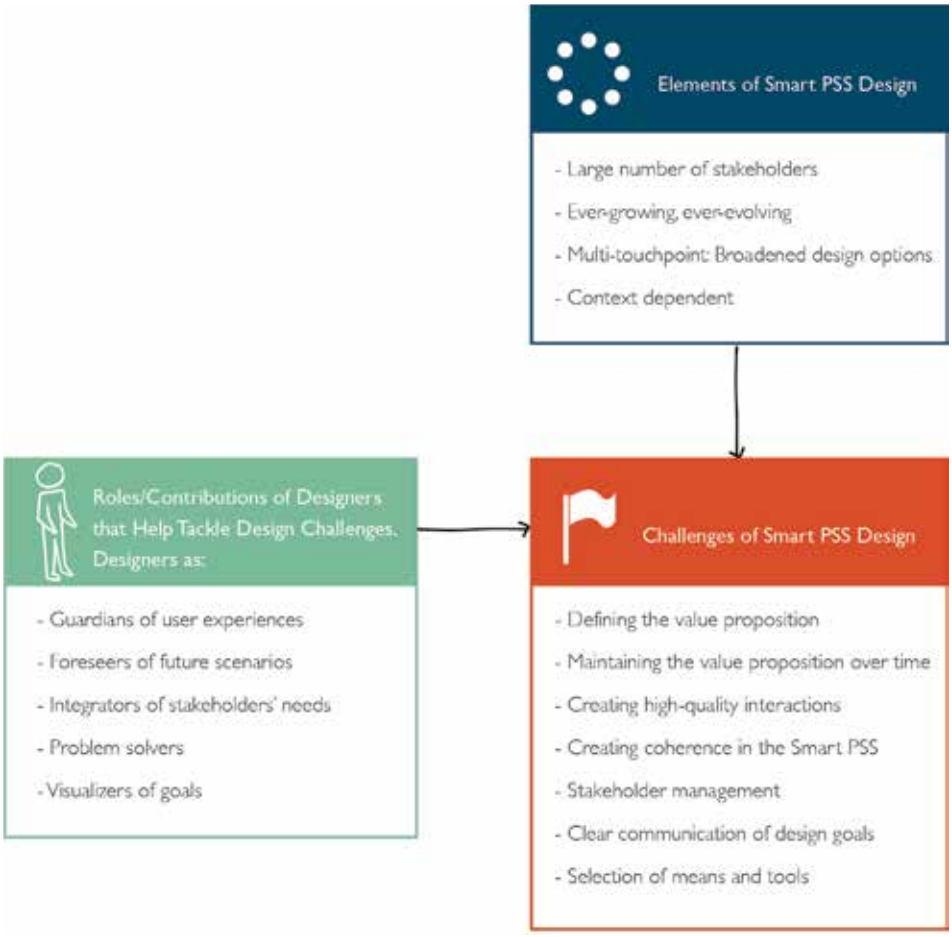

Figure 4.7 Overview of the findings of Study #2

In relation to the roles/contributions of designers, Morelli (2003) discusses the perspective shift needed from designers for the design of PSSs, from traditional design to design management. Our study demonstrates similar conclusions. The large number of stakeholders associated with Smart PSS design, but also the ever-growing, ever-evolving nature of Smart PSSs, call for design skills that contribute to the coordinated development of these design projects. In this regard, we have discussed several such skills, such as the ability to integrate stakeholder demands, facilitating discussions by asking relevant questions, and maintaining a broad view of the whole system. Importantly, these skills can help achieve coherence within the system, as they facilitate the identification of needs/roles of different stakeholders, the shared understanding of design goals among them, and the relation between the elements of the Smart PSS. However, the relevance of these process-related

roles and contributions (Valencia et al., 2013) does not mean traditional design skills loose prevalence. On the contrary, design skills, such as that of understanding users needs, problem solving, and visualizing, have important implications for how design goals are understood and devised. It is through these traditional design skills that designers help managers deal with the complexity associated with Smart PSS design, and contribute to its effective management.

The design skills discussed in this chapter are not new and have long been discussed in the design and design management literature, among others, by Morelli (2003, 2006), Mozota (2002), Sanders and Stappers (2008), and Valencia et al. (2013). Thus, based on our findings, we can conclude that designers can make use of their existing skill set, implementing them in the new development context of Smart PSS design. What is needed is an a-priori understanding of the elements of Smart PSS design and the new specific challenges associated to this design activity, which can help designers to adapt their best practices (i.e., tools, methods, approaches) accordingly. The findings outlined in this thesis allow designers to understand the strategic role they can play in the design of Smart PSSs and to take an active role in the process-related aspects of the Smart PSS design. Furthermore, the results presented in the chapter can help designers anticipate the challenges ahead during Smart PSS design projects. Importantly, the presented results can support designers in identifying their best assets for the design of Smart PSS design, to position themselves and to align their roles with other stakeholders, and to contribute to a more effective design process and value creation through the Smart PSS.

Finally, in relation to design tools/methods/approaches, we believe designers should assess the appropriateness of their toolset for the design of Smart PSSs (Morelli, 2006). At the moment, designers predominantly use existing product and service design tools in the design of Smart PSSs. Designers are adapting these to the design of Smart PSSs, and their use appears to be effective for certain steps in the design process. Interestingly, we did not find evidence concerning the use of design tools specifically associated with the design of (traditional) PSSs, such as system mapping (van Halen, Vezzoli, & Wimmer, n.d.), which could be a useful tool to manage stakeholders and other actors in the design of Smart PSSs. Importantly, the tools that are currently in use do not sufficiently address some of the challenges of Smart PSS design. Particularly, defining the Smart PSS value proposition, as well as the effective communication among stakeholders of this proposition as the system evolves requires particular attention and could benefit from the development of new design tools/methods/approaches.

Limitations

Study #2 allowed us to tap into the experiences of design professionals while designing Smart PSSs. While our research approach allowed us to achieve a better understanding of the Smart PSS design process, it also posed some limitations and

provides opportunities for further research.

First, our findings are based on the experiences of design consultants, traditional manufacturing companies, and providers of Smart PSSs. Our study did not include traditional service companies moving into the manufacture of products. We expect similar challenges to be faced by productizing companies, however, these might face distinct challenges rooted in their inexperience developing tangible products. Thus, future research is needed that focuses on productization cases, to broaden the understanding of Smart PSSs under different circumstances, which can help designers be prepared for various Smart PSS development contexts.

Second, our findings are based on the views designers (and design thinkers) have of their own work and their contribution to the design process. Future studies could broaden the scope and include other important actors in the development network (e.g., technology specialists), which can lead to the identification of new challenges and/or contributions of designers. Our findings are a first step in identifying the key characteristics of Smart PSS design; addressing a fraction of the aspects that can lead to the successful management of Smart PSS design processes. Future studies should deepen this knowledge, for example, by defining the critical phases in the design of Smart PSSs, where challenges are more likely to occur, or diving deeper into challenges to better understand their antecedents. Such research can lead to the development of specific key design tools to effectively support the design of Smart PSSs.

Finally, our research has highlighted the need for designers to adapt their best practices to Smart PSS design, and the opportunity to create tools to tackle Smart PSS design challenges. However, while diverse design tools were reported during Study #2, their effectiveness in tackling specific design challenges was not measured. Thus, future research is needed that focuses on these design tools and the extent to which they contribute to tackle specific design challenges. Likewise, many of the challenges described in this chapter, such as 'defining the value proposition', 'maintaining the value proposition over time', and 'creating high-quality interactions', have an effect on the meaning and value consumers attach to Smart PSS propositions. However, in order to develop new tools/methods/approaches that are effective, designers must first understand the aspects that shape the experiences of users with Smart PSSs. Chapter 5 aims to address this question and sheds light into the aspects that can be manipulated by designers to create Smart PSS propositions that are valued and cherished over time by consumers.

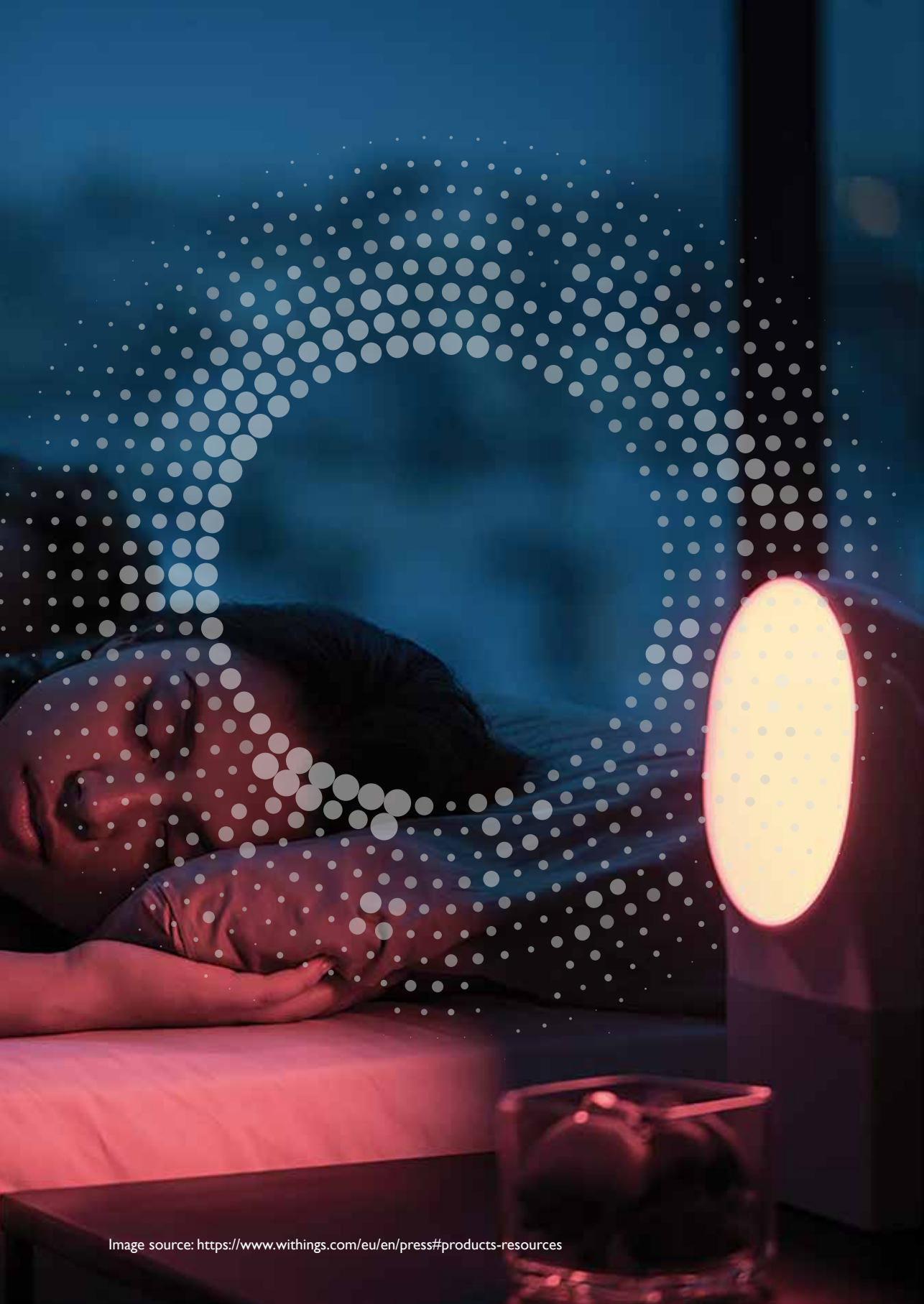

Image source: https://www.withings.com/eu/en/press#products-resources

5. Consumers' reactions to Smart PSSs[11]

11 Parts of this chapter are an adaptation of: Valencia, A., Mugge, R., Schoormans, J. P. L., and Schifferstein, H. N. J. (2011). Designing a Product Service System: Does congruity add value? *Proceedings of the Design Academic Management Conference, Cambridge, United Kingdom.*

Providing accurate insight about Smart PSSs design would not be possible without exploring how consumers react to these market propositions. Just imagine a scenario where designers are to make use of the design characteristics of Smart PSSs (Chapter 3) to define a new market proposition. Questions such as: Are all characteristics equally relevant? Are there instances when a characteristic is not advised? And, do all characteristics appeal to consumers in a similar way? are likely to be encountered by designers new to this particular field. In principle, the answer to these questions should be a straight no, as the needs and experiences of consumers with Smart PSSs are expected to be similarly influenced by intrinsic aspects of consumers and context (Section 2.3), just as with other products and services. However, there are two particularly important aspects with potential great implications to how consumers react to Smart PSSs, our understanding of the characteristics of Smart PSSs, and how these could be best used to define new market propositions. And these aspects need to be considered before providing conclusive advice to designers.

The first aspect is the multi-touchpoint nature of the experiences of consumers with Smart PSSs. This aspect was brought up as a topic of concern for design professionals in our early discussions with industry partners. Particularly, the issue of coherence between different touchpoints and how they affect consumers' reactions, and experiences, was brought up as a key concern. Later in the research,

the creation of coherence among different touchpoints was indeed validated as an important challenge of the design of Smart PSSs, with two types of coherence being discussed among design professionals: visual coherence and coherence of interaction (Section 4.3.2), as affecting the experiences of consumers. Consequently, the voiced concerns of design professionals in our research network highlight the importance of coherence as a topic of research in relation to consumers. However, thus far, these concerns are to a large extent anecdotal and more empirical evidence is needed to better understand how consumers react to having multiple touchpoints and their coherence. This information is important because it can help designers better manage the creation of valuable Smart PSS propositions to consumers.

The second aspect of importance to be considered in the definition of new Smart PSS propositions is the ever-growing, ever-evolving nature of Smart PSSs (Chapter 4, Section 4.2.1). While this characteristic represents clear opportunities for designers, it also highlights the aspect of temporality of the system. From a consumer's perspective, temporality means that the relationship and needs towards the Smart PSSs change over time (Karapanos, 2013). These changing relationships (and needs) can highly influence the way Smart PSS propositions should be defined. For example, what characteristics have more prevalence in the early interactions of consumers with Smart PSSs, and which gain prevalence later in the interaction? Do consumers derive value from the same characteristics over time? What aspects contribute to the recurrent and prolonged use of the Smart PSS by consumers? These questions must be addressed in order to provide designers with insights that can better equip them for the development of Smart PSS value propositions. Furthermore, temporality highlights the fact that consumers' interactions with the Smart PSSs, and the value they derive from it, cannot be separated from users' contexts. For example, the work of Secomandi (2012) (discussed in the literature review of this thesis) highlights the possible social interactions (e.g., people asking about the new product) influenced by the adoption of a Smart PSS, which can have positive and negative consequences for the experiences and value consumers derive from the Smart PSS. These rich accounts are more easily attainable when the context of the user is included in the study of his/her experiences. These types of aspects are made evident when the temporality of the user experience is taken into account while studying consumers' reactions to Smart PSSs.

The goal of this chapter is thus to investigate the last research question in this research project: *How can designers trigger positive responses with Smart PSSs?* To this end, we address the two issues outlined above through two separate studies. Study #3 addresses the issue of coherence by means of an experimental study, as will be explained in Section 5.1. Furthermore, Study #4 addresses the issue of temporality, looking to understand how consumers interact with Smart PSSs for an extended period of time, and the aspects that influence the recurrent interaction and value creation through the system. Throughout the thesis, we have gained

relevant insights that point to a complex and somewhat different experience of users with Smart PSSs. With this study, we come full circle in our research, seeking to understand how our previous findings relate to the creation of meaningful Smart PSS value propositions, which can help designers trigger positive responses among consumers. The following sections present the details of these two studies. The chapter closes with an overall conclusion on both studies.

5.1 Study #3: The value of coherence

The term coherence refers to the extent to which two or more objects (e.g., products, brands, people, images, companies, text, groups), resemble each other. This resemblance can take different forms: meaning, functionality, usability or shape can all influence coherence. Past research has studied the effect of coherence (a.k.a. congruity) on consumers' perceptions and evaluations of products or services (Bitner, 1992; Bosmans, 2006; Mattila & Wirtz, 2001; Patrick & Hagtvedt, 2011; van Rompay et al., 2010). Van Rompay et al. (2010), for instance, studied coherence effects for services purchased through a website. In their research, coherence was defined by the resemblance in (symbolic) meaning, elicited by the different elements depicted in the website (i.e., text and product image). Thus, a picture advertising a hotel that is cozy should be accompanied by describing text reflecting the same attributes. Conversely, a picture-text combination that does not share the same attributes can create negative effects on the shopping experience. Other studies have found similar findings for different scenarios (Bitner, 1992; Bosmans, 2006; Mattila & Wirtz, 2001; Patrick & Hagtvedt, 2011), and confirmed the importance of coherence when designing positive consumers' experiences towards products and services.

In the case of Smart PSSs, coherence is highlighted by the fact that several touchpoints are available to consumers when interacting with the system. Consumers have tangible products, digital servicescapes, service employees, etc., which they use to make inferences about quality. This aspect is further highlighted by the fact that touchpoints in the Smart PSS may have different characteristics, and hence, interact with the consumer in different ways (Section 2.3.2). Despite these intrinsic differences, Smart PSSs bundle products and services into one complete offering, and the integration of smart product and (e-)service elements with different characteristics may influence the way consumers evaluate the Smart PSS.

Take for example Philips' Direct Life (Figure 5.1). Consumers of this Smart PSS may make use of different cues to draw inferences about quality. Product attributes, such as the material the product case is made of, its shape and size, and the sounds it produces while measuring data, can all be used by consumers while assessing the value and quality of the smart product (Schifferstein & Desmet, 2008). Furthermore, for the e-service, consumers may turn to contents in digital servicescapes, such as layout, graphics and text, to make inferences about quality (Harris & Goode, 2010; Udo, Bagchi, & Kirs, 2010).

Figure 5.1 Direct Life

However, consumers evaluate products and services in an integrative manner by combining the different cues available in their evaluation (Bitner, 1992; Mattila & Wirtz, 2001; van Rompay et al., 2010; van Rompay, Pruyn, & Tieke, 2009). Thus, while interacting and assessing Smart PSSs, both smart product and (e-)service elements may become particularly important for consumers' evaluations of the offering. Consumers may not only look at the tangible elements of the smart product but also turn to elements of the digital servicescapes to draw conclusions about the total Smart PSS. Furthermore, the intrinsic differences between products and services represent a challenge for the successful integration of these elements from a consumer's perspective. The symbolic benefits that consumers experience in the various elements of a Smart PSS may differ or even conflict. For example, a fully customized e-service element may provide the important symbolic benefit of self-expression because it conveys a person's uniqueness, whereas a standardized smart product element may fail to do so (Mugge et al., 2009). Failure to provide a coherent experience can be expected to confuse the consumer, and ultimately, damage the user experience.

To exemplify the above, a user of Direct Life may be particularly proud of the numbers presented through the e-service. Data are highly individualized; they are a reflection of the individual activities of consumers throughout the day. Thus, consumers may proudly share them with family, friends and health experts, especially when goals related to activity and weight loss have been met. Sharing these numbers may help them position themselves as 'healthy' and 'sporty' among their peers; and to be perceived in a way they aspire. However, if the same consumer finds the smart product 'not likable', conflicting with the way he/she wants to be perceived, he/she will be discouraged to wear the smart product at all times, ultimately affecting the results the consumer achieves with the Smart PSS.

To conclude, past research has investigated the effect of coherence for services or products separately. Despite the relevance of developing coherent Smart PSSs (and PSSs) that are perceived as one total offering, research on how consumers experience PSSs is limited. With this research we contribute to the literature by investigating how consumers evaluate Smart PSSs. Our research (sub) question can be summarized as follows:

> ***What is the effect of coherence between product and service elements on consumers' evaluations of Smart PSSs?***

Specifically, we explore the influence of coherence with respect to the conveyed symbolic meaning (i.e., by both the service and product elements) on consumers' evaluations of the Smart PSS. Our research assumptions are based on past work by Van Rompay (2010) and Campbell and Goodstein (2001), who found high levels of coherence to reduce the associated risk of acquiring new products and services. Campbell and Goodstein (2001) describe perceived risk in terms of uncertainty and consequences. Thus, a consumer looking to acquire a new Smart PSSs (e.g., Direct Life), could develop associations of high risk with the purchase when he/she is unfamiliar (i.e., uncertain) about the quality of the smart product. Moreover, the consumer could associate a high risk with the purchase, when he/she is concerned about the efficacy of the Smart PSSs in helping him/her loose weight. Importantly, Campbell and Goodstein's study (2001) demonstrates that when high risk is present, consumers evaluate those offerings that are congruent with their expectations more positively.

Based on the above, we anticipate potential discrepancies between product and service elements in a Smart PSS to look unreliable on the eyes of consumers, create uncertainty, and negatively affect their evaluations of the Smart PSS. In contrast, a high level of coherence between the product and service elements may reduce the associated risk of the Smart PSS because it gives consumers *assurance*, which will positively affect their attitudes towards the solution. Our research assumptions are summarized in Figure 5.2.

Figure 5.2 Research model Study #3

5.1.1 Method Study #3

In this research, we focus on achieving coherence through the symbolic meaning 'professionalism' that is evoked by both the product and service elements of a PSS. This symbolic meaning is often included in products and services, and is shown to positively affect the quality perception of the offering (Mugge, 2011).

A 2x2 between-subjects experimental design was carried out were participants had to evaluate a PSS with varying levels of coherence. This method was deemed appropriate as it has been previously employed in the study of coherence and its impact on consumers' evaluations of products and services (e.g., Aggarwal & McGill, 2007; Bosmans, 2006; Campbell & Goodstein, 2001).

We believe the issue of coherence to be relevant to both Smart and traditional PSSs. Consequently, we opted for a car rental company whose service is facilitated and promoted through a website as stimuli to the study. This variation of a PSS represents a bridge between more traditional PSSs and Smart PSSs. Rental car companies are often mentioned as an example of traditional PSSs in the literature (e.g., Baines et al., 2007; Williams, 2007). Moreover, rental cars (i.e., the product) may have a smart character, because the service is electronic in nature and closely resembles that of a Smart PSS. By following this approach, we aim to attain more generalizable findings that are relevant for both traditional and Smart PSS propositions. The e-service was used to manipulate the coherence between product and service elements. Websites are important platforms to access relevant product and service information of a solution, and likely to influence the evaluations and final decisions of consumers towards offerings (Harris & Goode, 2010).

Design and participants

One hundred and twenty-nine participants took part in this study. Participants were Dutch citizens in the age range of 19 to 73 (50% male, mean age = 32.91, *SD* = 9.08).

We created a website for a fictional rental car company, Renta Flex, as stimulus material. The product was represented by a picture of a car with a company logo

on it, while the service was represented by a service description accompanied by an employee photo. Four versions of the website were created, which varied in the level of coherence (i.e., professional product and professional service, professional product and non-professional service, non-professional product and professional service, non-professional product and non-professional service). Two pre-tests were conducted to confirm the appropriateness of our manipulations and selection of stimuli. Pre-test 1 focused on the selection of pictorial representations of product and service elements, while Pre-test 2 focused on the written description of the service.

Pre-test 1: Car, logo and employee image

Car, logo and employee image were pretested using separate questionnaires for the same participants (N=50, 44% male, mean age = 24, SD = 2.40). To create a more and less professional version of a car (i.e., the product), both the color of the car and the size of the company logo were manipulated. Volkswagen Golf was chosen as the stimulus product as it is a type of car that is often used by rental car companies around Europe. The Volkswagen Golf was presented in six different colors (i.e., black, yellow, dark blue, red, grey, and light blue), which were obtained from the official Volkswagen website to guarantee realism. All pictures made use of the same product view and image quality to guarantee consistency. Participants were asked to rate all six cars on their professionalism on a three-item, seven-point semantic differential scale (i.e., (not) professional, (not) business-like, (not) serious). Moreover, the attractiveness of the car was checked for confounding effects on a one-item, seven-point scale, anchored by unattractive and attractive. The cars in the colors grey (M = 5.47, SD = 1.02; α = 0.87) and light blue were selected (M = 3.25, SD = 1.02; α= 0.77), as the professional and non-professional car, respectively. These cars differed significantly on the perceived professionalism (p < 0.001), while no difference for the perceived attractiveness of the cars was found (p > 0.05). Both analyses were conducted using Bonferroni as post hoc test.

A trained designer created a fictional logo for the rental car service company. Professionalism of the company logo was manipulated by changing the size and position of the logo on the car, and pre-tested using the same professionalism scale as previously reported. Five logo variations were presented to the participants. We selected the logos with the highest and lowest scores on the professionalism scale as stimulus material (M = 5.41, SD = 0.91; α = 0.79 versus M = 3.15, SD = 1.1; α = 0.75; F(4, 180) = 54.92, p < 0.001). The selected cars and logos were combined (i.e., professional car and professional logo vs. non-professional car and non-professional logo), making use of photo-editing software to create the two product variations.

Finally, to select employee pictures (i.e., the service) with either a more or less professional image, twelve pictures of a person varying in pose (e.g., thumbs up, crossed arms, extended hand) and formality of clothes (e.g., suit and tie, only tie,

no tie or jacket), were created and pretested. Participants were asked to rate all employee pictures on the three-item professionalism scale. The employee pictures with the highest and lowest scores on professionalism as stimuli (M = 5.53, SD = 0.80; α = 0.77 versus M = 3.80, SD = 1.10; α = 0.88, $F(11, 517) = 38.96$, $p < 0.001$) were selected.

Pre-test 2: Service description

Two service descriptions were created, where tone and wording were changed in either a more or less professional text. The structure and meaning of the text were kept consistent across conditions. Forty participants (75% male, mean age = 22, SD = 2.39) were asked to rate one of the two service descriptions on the three-item professionalism scale (α = 0.83). An independent samples t-test revealed significant differences in the perceived professionalism between both descriptions (M = 5.47, SD = 0.68; vs. M = 3.77, SD = 1.17, $t(38) = -5.62$, $p < 0.05$), confirming the success of this manipulation. These service descriptions were combined with the selected employee images (i.e., professional service description and professional employee vs. non-professional service description and non-professional employee), to create two service variations.

Final Stimuli: Picture of a Website

The selected stimuli, product and service elements, were brought together in a picture of the website. The website promoted the Renta Flex company and enabled consumers to identify the location of a car and book the offering. This resulted in four different pictures: two conditions in which the product and service elements were coherent and two conditions in which the product and service elements were not coherent. The pictures were created making use of professional photo editing software and were standardized in terms of size and quality. Figure 5.3 depicts the professional product-professional service website, and the non-professional product and non-professional service website.

Procedure and Measures

Four online questionnaires were created, one for each of the conditions. Participants were contacted via email and assigned randomly to one of four conditions. To encourage participation, a small monetary incentive was offered to every third respondent.

Participants were first asked to imagine themselves as potential Renta Flex customers (Appendix D). In this scenario, participants were asked to imagine themselves as owners of a small business, who do not possess a car themselves, and who contact Renta Flex expecting them to be a good representation of their own businesses. As such, participants would have a scenario in mind were social approval was needed, and the risk of being misrepresented by the solution. Subsequently,

A. Non-professional product and non-professional service

B. Professional product and professional service

Figure 5.3 Example of stimulus material used in Study #3

they were shown the picture of the website and were instructed to observe and read the content carefully. The image of the website was made available to participants throughout the questionnaire.

We measured attitude towards the PSS by means of a three-item, seven-point differential scale (i.e., bad/good, unfavorable/favorable, negative/positive), inspired by the work of Campbell and Goodstein (2001). We measured assurance with three seven-point Likert scales: "I consider Renta Flex's offering to be a safe business decision", "I would feel confident if my clients saw me using the Renta Flex offering" and "I would feel assured about Renta Flex's support when needed". The scales were anchored from 1 (strongly agree) to 7 (strongly disagree) and inspired by the same work (Campbell & Goodstein, 2001). Finally, we assessed the perceived coherence of the offering with two seven-point Likert scales: "Renta Flex presents a coherent offering to its clients" and "The offered car matches with the service that Renta Flex provides".

5.1.2 Results Study #3

Reliability and Validity of the Measures

The internal consistency and convergent validity of the scales to measure attitude, assurance, and coherence was investigated by performing a confirmatory factor analysis (CFA) on all items of the latent variables using ML-estimation in LISREL 8.72 (Jöreskog & Sörbom, 1993). The results indicated a good fit to the data (χ^2 = 26.50, df = 17, χ^2/df = 1.56, p = 0.07; GFI = 0.95, CFI = 0.99, RMSEA = 0.066). Convergent validity was indicated by the fact that the items loaded significantly on their corresponding latent construct (all t's > 2.0) (Bagozzi, Yi, & Phillips, 1991). Discriminant validity among the scales was assessed as follows. First, a baseline model (in which the correlations between pairs of constructs were freely estimated) was estimated for each possible pair of scales. Next, we compared this baseline model to a series of alternative models, in which the correlations between pairs of constructs were constrained to unity (Anderson & Gerbing, 1988). In each case, the constrained model exhibited a statistically increase in chi-square ($\Delta\chi^2$ (1) > 3.84), providing evidence of discriminant validity (Bagozzi & Phillips, 1982). Furthermore, the reliability of each scale was explored by computing the reliability coefficient or Pearson's correlation ($\alpha_{attitude}$ = 0.88; $\alpha_{assurance}$ = 0.83; $r_{coherence}$ = 0.45). Together, these results indicated a sufficient degree of reliability and validity of the scales.

Manipulation and Confounding Checks

Based on an exploration of the boxplots for the variable coherence, three outliers were removed from the dataset. Next, an analysis of variance showed that the manipulation of coherence between the product and service elements of the PSS

was successful and resulted in variations in coherence. As intended, a significant interaction effect between product and service was found on coherence ($F(1, 111) = 7.51$, $p < 0.01$). Specifically, participants who were presented with the professional product, perceived the PSS to be more congruent when the service had a professional image than when it had a non-professional image ($M_{prof} = 4.30$, SD = 1.25 vs. $M_{non\text{-}prof} = 3.78$, $SD = 1.08$, $t(67) = 1.80$, p = .08). In contrast, participants who were presented with the non-professional product, perceived the PSS to be more congruent when the service had a non-professional image than when it had a professional image ($M_{prof} = 3.98$, $SD = 1.04$ vs. $M_{non\text{-}prof} = 4.58$, $SD = 0.76$, $t(44) = -2.27$, $p < .05$). No other effects were found.

Test of the Model

In order to test our research model, we estimated the structural equation model with latent variables in LISREL 8.72. The fit statistics for this model indicated a good fit ($\chi^2 = 26.58$, $df = 18$, $p = 0.06$, $\chi^2/df = 1.48$, GFI = 0.95, CFI = 0.99, RMSEA = 0.061). This model explains 67% of the variance in consumers' attitude towards the PSS. The results provided support for our conceptual model. Specifically, the degree of coherence between the product and service elements of a PSS had a positive effect on the perceived assurance of the offering ($b = 0.85$, $p < 0.05$). Furthermore, the perceived assurance positively affected consumers' attitude towards the PSS ($b = 0.82$, $p < 0.05$). The estimated model is presented in Figure 5.4.

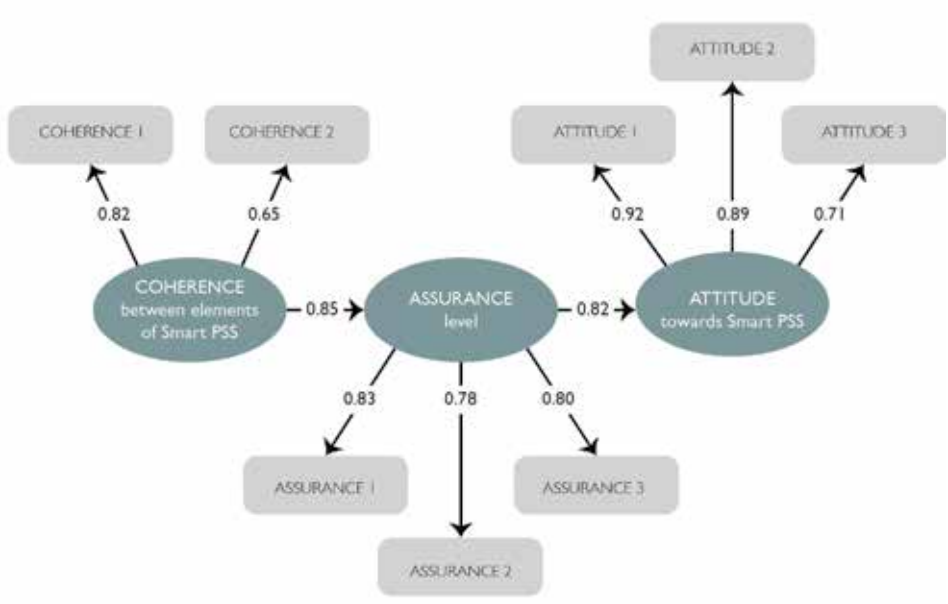

Figure 5.4 Results of Study #3

5.1.3 Conclusion and Discussion Study #3

In this study, we have explored the role that coherence in the elements of a Smart PSS plays on consumers' evaluations of the offering. Our results suggest that consumers who evaluate a (Smart) PSS through its e-service, value the coherence of meaning between product and service. Furthermore, following the work of Campbell and Goodstein (2001), we have found evidence suggesting that coherence can reduce the perceived risk associated to online transactions and unknown offerings. When confronted with new (Smart) PSSs, coherent offerings can evoke assurance with consumers, resulting in a more positive evaluation of the complete offering. Previous research has studied the effects of coherence for products or services separately (e.g., Bitner, 1992; Bosmans, 2006; Mattila & Wirtz, 2001; Patrick & Hagtvedt, 2011; van Rompay et al., 2010). Our findings add to these theories by exploring these effects for offerings where both products and services are important to consumers. Moreover, we broaden the understanding of how consumers evaluate (Smart) PSSs, in order to create new guidelines for practitioners on how to successfully design and market these new offerings.

The findings of Study #3 have several implications for practitioners. First, differences between the service description and attributes of the product have not passed unnoticed by participants. Designers and marketers need to pay close attention in defining the message the (Smart) PSS should convey, and match such impressions with those of the product and service elements that define it. Thus, product and service elements should not be developed separately. An overall narrative of the total offering should be created, one where consumers' experiences with the (Smart) PSS are clearly defined. Second, practitioners should clearly establish the perceived risk associated to their offerings. In new Smart PSSs where perceived risk may be high (e.g., due to unknown technologies or functionalities), coherence between product and service elements could reduce that perceived risk as much as possible, and positively influence consumers' evaluations towards the total offering.

Limitations

Our research methods allowed us to explore the role of coherence on consumers' evaluations of (Smart) PSSs in a controlled setting. Furthermore, our choice for stimuli allowed us to reach results that are relevant to Smart PSSs as well as to traditional PSSs, broadening our contribution to the existing literature. However, the used set up also posed some limitations, which leaves us with some questions open for further research.

First, we have opted for a car-rental PSS, which is often mentioned in the PSS literature. This type of PSSs is increasingly being implemented with smart capacities, and its service is facilitated by web platforms and apps (e.g., booking cars via apps). These characteristics, particularly the implementation of e-services, made our PSS

choice a good fit to our aim. However, the descriptions used in the study did not stress the smart attributes of the product or its embedded technology. While we do not expect to find considerable differences in the results of the study, if such descriptions were included (for the study of coherence in symbolic meanings), other results could be obtained while studying coherence in a Smart PSS from a different perspective. Other aspects, such as functionality, usability or shape can have coherence effects on the evaluation of Smart PSSs. Hence, further research is needed to better understand these phenomena and the relative importance of these factors on the evaluation of Smart PSSs.

Second, our study focused on one specific type of PSS and for one particular context (i.e., professional use). However, the nature of the interaction between consumer and service provider, and the perceived risks associated with the purchase, can differ considerably between Smart PSSs. For example, Nike+ encompasses a smart product to track running distances, and an e-service where consumers can store their data, look at development graphs, and get in touch with other Nike+ users. In this case, consumers are actively involved with the service and have continuous contact with other users. Consequently, the community becomes a much more important aspect of this particular Smart PSS than for a rental car service company. Thus, as discussed above, the perceived risk associated with the purchase could lie in other aspects, such as functionality or performance, and could thus have different effects on consumers' evaluations of the offering. Consequently, further research should set out to explore the role of ownership, interaction (e.g., community dynamics), and perceived risk of (diverse) PSSs, in order to fully understand the effect of coherence on consumers' evaluations of PSSs.

Finally, our research used a picture of a website to characterize the PSS. The offering was hypothetical and participants had no personal and real experience to base their evaluations on. While this method allowed controlling for important variables, such as the predisposition towards brands, and to easily manipulate the professionalism of product and service, it restricted our access to consumers' first impressions when evaluating the PSS. To obtain a deeper understanding of how consumers experience Smart PSSs, it would be desirable if participants interact with both smart product and e-service. Furthermore, as argued for in the introduction of this chapter, temporality is an important aspect in the study of Smart PSSs, which is not address in Study #3. Consequently, Study #4, our second effort to understand consumers' reactions to Smart PSSs, seeks the use of more realistic, less controlled settings, where consumers can experience the service and product elements first hand, thereby enhancing the external validity of their evaluations. We also seek to include temporality on the study of Smart PSSs, allowing consumers to go through different phases in their interactions with the offering, granting us access to insight in their changing experiences (and needs) over time with the Smart PSS.

5.2 Study #4: Temporality in the use of Smart PSSs

In this thesis, we define *temporality* as 'how users' experiences develop over time' (Karapanos, 2013, p. 58). These developments or changes in their experiences relate to their needs towards the products and services they interact with, and the value they derive from them. Several authors have highlighted the importance of temporality in the understanding of user experiences, and the design of offerings with lasting value to consumers (e.g., Forlizzi & Battarbee, 2004; Hassenzahl & Tractinsky, 2006; Karapanos, 2013; Kujala, Roto, Väänänen-Vainio-Mattila, Karapanos, & Sinnelä, 2011). In relation to temporality in the experiences of users with Smart PSSs, we consider the work of Karapanos (2013) particularly relevant.

Karapanos proposes a model for the temporality of user experiences with products. According to the model, every experience a user goes through is preceded by a stage of anticipation, the 'act' of forming expectations towards the products, which occurs prior to the actual experience takes place. Experiences are thus formed by a collection of individual interactions, defined by Kaparanos as 'micro-temporality'. Each of which may relate to different aspects of the product, such as its ease of use and/or aesthetics. As the aspect of the product that consumers focus on in each 'micro-temporality' changes over time, 'micro-temporalities' contribute to the formation of three distinct phases of the user experience. Namely, orientation, incorporation and identification.

Orientation relates to the first interactions of users with products. Because consumers may be confronted with new technologies, functionalities, and features, this phase is characterized by the learning process consumers go through. In Karapanos' study, positive experiences in this early phase were related to the products' ease of use, but also to its innovativeness in relation to aesthetics and the aesthetic of the interaction. Moreover, negative experiences were largely the result of learnability issues, or the adaptation process consumers go through in the interaction with new products/technologies. As such, consumers may experience feelings of frustration when tasks or actions do not develop as expected.

The second phase, *incorporation*, relates to how the product 'incorporates' into consumers' lives and gain meaning. In Karapano's study, accounts of positive experiences resulted from aspects related to the long-term usability of the product, and its usefulness in supporting the daily activities of consumers (e.g., providing fast access to information) over time. Moreover, accounts of negative experiences were the result of functional expectations that were not met, and long term usability problems.

The third phase is *identification* and relates to how the product is finally accepted into the lives of consumers, and how consumers develop personal relationships with them. Karapanos distinguishes between two types of identification: personal and social. Personal identification refers to how users invest time in personalizing

and adapting the product, so that it better reflects their individual preferences (e.g., organizing and displaying apps in a specific way). Another marker of this type of identification is when consumers associate the product with daily personal rituals (e.g., using the product every day for a specific task).

Moreover, social identification relates to how products can have an influence on the social self. In this regard, Karapanos discusses two aspects that can be influenced by products. First, products can serve as means of 'self-expression', particularly, in helping consumers differentiate themselves from others (e.g., having an exclusive product that a few have) (Creusen & Schoormans, 2005). Second, Karapanos discusses products as helping consumers develop a 'sense of community': a feeling of belonging to groups of users that share similar interests. Social identification is similar to the concept of 'group affiliation', which has been researched previously as a possible antecedent to product attachment (e.g., Kleine, Kleine, & Allen, 1995; Mugge, Schifferstein, & Schoormans, 2005).

Finally, Karapanos discusses the three forces that drive the transition between phases in the temporality of experience: increasing familiarity, functional dependency, and emotional attachment. In the transition from orientation to incorporation, consumers learn how to use the product and become familiar with it, resulting in a decrease of learnability issues. In the transition from incorporation to identification, consumers are more functionally dependent on the product, and as described above, their experiences are more centered on the long-term usability of the product. Finally, as consumers fully incorporate a new product in their daily lives, they might develop feelings of attachment towards the product. The force of attachment, Karapanos concludes, is closely related to the type of product studied in his research. The iPhone is a type of product that consumers carry with them all the time, and as demonstrated, influences consumers' social interactions. Other feelings may be of relevance when other types of products are considered. For example, a washing machine may trigger feelings of indispensability, due to its more functional character.

We expect the phases and driving forces identified by Karapanos to also be applicable to users' experiences with Smart PSSs. Smart PSSs are complex offerings where consumers will likely endure a process of orientation towards the system and its elements. Moreover, consumers will likely need to experience the Smart PSS, and achieve an understanding of the value that product and service elements embody, before the Smart PSS can be fully integrated into their lives and routines. Thus, Karapanos' work is particularly insightful to our purpose, as it breaks the user experience in distinct phases, allowing us to anticipate how consumers' experiences with Smart PSSs will unfold. However, Karapanos' study of user experiences centers on the interactions of users with a single product, namely, the iPhone. Even though the iPhone and its accompanying applications could be considered a Smart PSS, his study focuses on the value provided by features of the phone and not its accompanying services. Consequently, further study is necessary to better

comprehend the experiences of users with Smart PSSs, where both the product and service, and in some cases several products and several services, play a significant role in the experience formation of users.

Furthermore, as argued in the introduction of this chapter, Smart PSSs are often composed of several touchpoints, all of which can influence the experiences of users with the Smart PSSs. Coherence, as found in Study #3, can influence the experiences of users with Smart PSSs, and could also influence the 'incorporation' of the Smart PSSs into consumers' lives and in the long-term, recurrent use. However, our previous study excluded important contextual information, which can influence how consumers interact, experience and evaluate Smart PSSs.

Consequently, the purpose of this study is twofold. First, we aim to attain a better understanding of the temporality of user experiences with Smart PSSs, where both product and service play a key role. In particular, our goal is to better comprehend how the experiences of users with Smart PSSs develop over time, pointing out important differences with the experiences of traditional products. Second, we are particularly interested in the transition from orientation to the incorporation phase (Karapanos, 2013) as we believe this transition to be especially relevant for the successful implementation of Smart PSSs that are meaningful, valued and cherished by consumers in the long-term. Thus, our goal is to obtain insights into the factors that positively affect (or detriment) the incorporation of Smart PSSs into consumers' lives. These factors may relate to coherence but also to other aspects highlighted throughout this thesis (e.g., characteristics of Smart PSSs), which can have a potentially relevant influence on the formation of meaningful user experiences. Our research aims are summarized in the following sub-questions:

> ***How do consumers' experiences with Smart PSSs develop over time? And,***
>
> ***What factors should designers consider when defining user experiences with Smart PSSs?***

We now proceed to describe our research methods and findings.

5.2.1 Method Study #4

We followed a longitudinal, qualitative research approach to achieve our research goals. Our methods included different techniques, such as cultural probes and in-depth interviews (on the same participants), which granted us access to contextual information and personal accounts about the meaningful experiences of participants with Smart PSSs (Karapanos, 2013; Patton, 2002; Sleeswijk Visser & Visser, 2006). A total of twelve participants were recruited to interact with a specific Smart PSS for a period of 8 to 9 weeks. The choice for the research length was based on past

qualitative longitudinal user experience research. Karapanos (2013) carried out his longitudinal study on user experiences with products during a period of 4 weeks, while Secomandi's study of the service interface allowed participants to interact with the Smart PSS for a period of about 8 weeks (2012). To account for the potential increased complexity of Smart PSSs, and its impact on users' experiences, we follow Secomandi's lead. The chosen period of 8 to 9 weeks is expected to give participants sufficient room to explore the Smart PSS, and to go through the temporality phases previously discussed.

Four different types of Smart PSSs were selected by the researchers and distributed among participants (i.e., one type of Smart PSS per three participants). As concluded in Chapter 3, we expect the characteristics of Smart PSSs to be context dependent. Moreover, past literature in fields such as user experience and service marketing, has highlighted the role that context or situational filters can have on the experiences and value consumers derive from offerings (e.g., Hassenzahl & Tractinsky, 2006; Sandström et al., 2008). Consequently, we use maximum variation sampling in our stimuli (Patton, 2002, p.235), and thus the Smart PSSs used in this study belong to different categories and use contexts. The goal is to collect in-depth data for the chosen cases to give detailed descriptions/illustrations of how the user-Smart PSS relationship evolves over time, while looking for significant general patterns across contexts. We proceed to provide a detailed account of the stimuli, procedure and analysis of data.

Stimuli

The stimuli used in this study can be divided into two main aspects: the Smart PSSs participants experienced for an extended period of time, and the cultural probes that helped them document their experiences with the system.

Smart PSSs

We conducted extensive Internet search and developed a list of 11 commercially available Smart PSSs that were used in various contexts and for various purposes (Appendix D). The Internet search was predominantly done via Google with the key words 'Internet of Things', 'Connected Products', 'Smart Product and Service'. Also, the contents of the Consumer Electronic Show (CES) portal and its YouTube channel were studied, to spot any new relevant commercial developments (at the time).

In order to select the final four offerings, an analysis of each offering was performed on the basis of the characteristics of Smart PSSs identified in Chapter 3. A wheel of characteristics was developed with the help of an industry partner, to help map the differences between specific offerings on the basis of the seven characteristics. The industry partner brought in a different perspective to the research, allowing us to arrive to a format to analyze and visualize the characteristics of Smart PSSs for specific offerings, in a way that could be potentially used as a tool by practitioners.

Importantly, the wheel indicates visually which of the characteristics of Smart PSSs are most relevant for specific value proposition. As such, the wheel allows drawing comparisons between Smart PSSs, highlighting how they differ on aspects of the value proposition.

Next, each of the eleven preselected offerings was mapped using the wheel of characteristics (Figure 5.5). To reduce the subjectivity of this task, two separate researchers completed this exercise and their results were subsequently compared and discussed to reach a final conlusion. At first, the following five Smart PSSs with significant differences in one or more characteristics were selected, to aid in our understanding of users' experiences of Smart PSSs across contexts: Fitbit, Amazon's Kindle, Green Wheels, Withings Aura, and Philips Hue. However, one of the pre-selected Smart PSSs, namely Green Wheels, was deemed unviable at a later phase of the research. Green Wheels is a use-oriented Smart PSSs, where consumers enter contracts and agreements in order to access the products provided by the system. The business model is of a complex nature, compared to that of product-oriented Smart PSSs, hence making it difficult to implement it as part of the research. The final four selected Smart PSSs (Table 5.1) were purchased through regular retail channels or directly from the Smart PSS developer. These Smart PSSs varied in price (100-250 Euro). However, this aspect was deemed irrelevant for the study, as the focus was placed on the temporality of the user experience, and the aspects influencing the continuous use of the Smart PSS, and not its monetary value (see section 'screening and selection of participants').

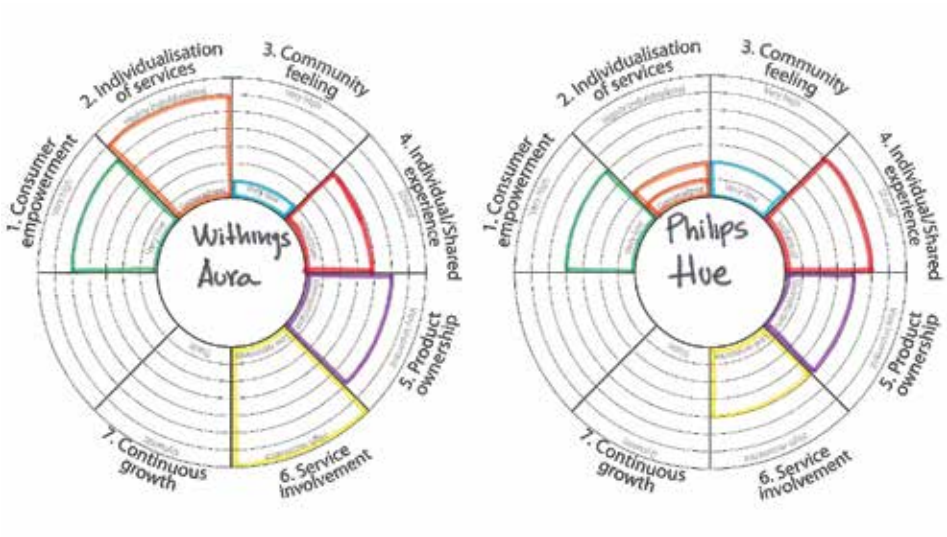

Figure 5.5 Impression of the wheels of characteristics used to select stimuli in Study #4

Table 5.1 Selected stimuli for Study #4

Smart PSS	Image	Smart Product	e-Service
Fitbit		Activity tracker	Dashboard: overview of quantified-self data; overview of calories intake, walked steps, and sleep quality. Premium account: the above, plus personalized 12- weeks fitness plan.
Kindle		e-reader with paper-like quality	Kindle store: purchase of e-books, borrowing books from public library, sharing personal library with family/ friends, preview of books, rating of books, connecting with Goodreads online community, and others.
Withings Aura		Sleep sensor that is placed under mattress. Light and sound bedside device.	App that helps track sleeping information, such as sleep cycles, movements, and heart rate. Analyzes sound, temperature and light levels throughout the night. Information helps user to understand the quality of his/her sleep over time.
Philips Hue		Smart bulbs and bridge, which helps control the lights remotely.	App that gives enhanced control to users over the light bulbs. The lights can be programmed to turn on and off at desired moments, for example, when away for the weekend for security reasons, to notify kids that it is time to go to sleep, or to show that an important email came in.

Cultural Probes

A key aspect to our understanding of the interactions with Smart PSSs was to allow participants to interact with the offerings, in their own environment (context), for

an extended period of time. Consequently, cultural probes were selected as the appropriate tool to stimulate users to think about their experiences while interacting with the Smart PSSs. The purpose of choosing this approach was to increase participants' awareness of meaningful experiences, and their ability to recollect those during the interviews with the researchers (Sleeswijk Visser & Visser, 2006).

In our particular case, we made use of a digital research tool called Contextmapp (http://contextmapp.com/). Contextmapp is an application that can be installed on users' smartphones. As our study involves the use of e-services, often accessed through mobile technologies, the use of a digital tool was deemed fitting. Contextmapp offered several advantages to our research. First, the tool granted participants direct access to research-related questions and tasks (anytime, anywhere), allowing them to collect rich contextual information, such as pictures and notes related to their interactions with the Smart PSSs (Figure 5.6). Second, the information collected through the tool is of digital nature and automatically uploaded to a web platform. This web platform granted us access to research-related data at all time, making it possible to track the progress of participants through the research (e.g., whether they understood and answered the questions/tasks timely), and intervene whenever needed. Moreover, it allowed processing the data prior to the final interviews with participants, and to use the information (i.e., pictures, text) during the in-depth interviews, helping them to conjure relevant experiences and discussions in relation to the Smart PSSs.

The cultural probes were designed by the main researcher and discussed in several sessions with the research team and a professional UX researcher. The goal of this procedure was to assure the quality of the probes and the appropriateness of questions and tasks. Cultural probes were developed around three topics: getting to know the service (i.e., orientation), engaging with the product and service (i.e., incorporation), and achievement of goals and intentions of continuity (i.e., from incorporation to identification). Furthermore, to avoid overwhelming participants with the number of questions, each topic was developed into specific modules that were sequentially unlocked by participants over time (per completion of each module). Modules were designed to be completed within a two-weeks period. Each module contained a set of questions and tasks related to the experiences and interactions of participants with the Smart PSS, and the influence of situational aspects and characteristics in the formation of these experiences. Table 5.2 provides an overview of the modules as explained to participants, and examples of questions/tasks for each module.

Finally, it was important to understand the effect that interactions with the Smart PSSs could have on the long-term moods of participants (e.g., cheerfulness, boredom, tension), to better assess the character of the experiences. In order to make the process of expressing moods easy and intuitive, we integrated the tool 'Pick-a-mood' for specific questions and tasks in the cultural probes (Desmet, Vastenburg, Van Bel, & Romero, 2012)(Figure 5.6, image C.).

Figure 5.6 Impression of the research tool Comtextmapp. a) Overview of topics and instructions in Module #1, b) Screen display of questions/tasks, c) Pick-a-mood as a tool to capture the moods of participants throughout their interactions with the Smart PSSs

Table 5.2 Overview of modules and examples of questions/tasks as seen by participants of Study #4

Module	Description	Example Questions/Tasks in Each Module
Module #1: Getting to know the product/ service	In this module you will document your first experiences with the product/service, such as its set up, and learning how to use it.	Document your impressions while setting-up and installing the product/service. List any positive, negative and surprising aspects of such a process. Use the product/service for a week or two and capture as many experiences as you can. Take a picture of the experiences you want to capture whenever possible. Describe whether you like it or dislike it.
Module #2: The service and I	In this module you will document your experiences and feeling while using the online service attached to the product you are using (e.g., app, web platform, website).	Capture the aspect/feature of the online service you like most by taking a photo or making a short video. You can also use a photo/ video you have saved/used before. Describe why you like this aspect/feature the most. How does using this online service aspect/ feature make you feel?
Module #3: The product/ service in relation to others	In this module you will be presented with tasks and questions in relation to your use of (product/service name), and how it influences your interactions with others.	Products/services often influence our interactions with people, such as family, friends and colleagues. Use the product/service for a few days or a week. Capture a moment where you feel the product/service influenced your interactions with those around you. Snap a photo or make a short video. You can also use a moment you captured before. Describe the experience. Who are those you interacted with? How did you interact? How did the product/service influence the interaction?
Module #4: The product/ service in relation to my goals and expectations	In this module we will explore how (product/service name) has fulfilled your expectations, and the impact it has had on your life.	Capture an experience you believe reflects how the product/service did NOT fulfill your expectations, or did NOT help you achieve your goals. Snap a picture or make a short video of this experience. You can also share an experience you documented before.

Procedure and Participants

The research was executed in three stages: screening and selection of participants, the use of the Smart PSSs, and post-use interviews.

Screening and selection of participants

The Product Evaluation Laboratory (PEL) at TU Delft was recruited to conduct the research activities, and the consumer panel of the laboratory used to reach potential participants. We sought to recruit participants with no prior experience with the Smart PSS at hand, and a genuine interest in the use of the Smart PSS (i.e., goal-oriented use). To this end, a questionnaire containing 33 questions was developed. The goal of the questionnaire was to assess consumers' previous experiences with the Smart PSSs, their goals towards each of the Smart PSSs, and their interest in taking part in the study. For example, for the Smart PSS Fitbit, the following questions were asked: *How important is it for you to maintain a healthy lifestyle? How satisfied are you with the way you maintain a healthy lifestyle? How important is it for you to understand your calories intake?* And, *How important is it for you to improve your physical condition?* These types of questions were formulated as 5-point, semantic differential scales (e.g., 1 = Not at all important/ 5 =Very important). An exception were the questions related to Kindle, where participants' reading habits where inquired by means of nominal, multiple choice questions (e.g., How do you get your reading material mainly? I buy them/I borrow them at the public library/I borrow them from friends and family/Other, namely). Furthermore, a series of filters were implemented to assess the fit of participants to our study. Specifically, participants who did not want to take part in a 2-months study, who did not own a smartphone (a prerequisite to installing the Contexmapp app), who already owned the particular Smart PSS or a similar device, who had previous experiences with the offering, who were not experienced in the use of a smartphone, and who could not answer the questions in English, were deemed as unsuitable to our research interests. The filters were implemented by means of nominal, single answer questions (e.g., Do you own a smartphone? Yes/No)

Three hundred and seventeen consumers were contacted and asked to take part in our research. Of these, a total of 143 were considered to be a good fit for the study (47% male, mean age = 50, *SD* = 11): these consumers indicated they were interested in participating for the totality of the study, that they owned a smartphone, had experience in the use of smartphones, and felt comfortable answering questions in English. Furthermore, we used criterion sampling (Patton, 2002, p. 238) to select the final 15 participants. To this end, answers of potential participants in relation to each Smart PSS were analyzed separately and individually, looking for participants with specific criteria, for example, in relation to their goals towards the Smart PSS. Regarding Fitbit, for instance, participants who answered with a score of four or more to the questions '*How important is it for you to live a healthy lifestyle?' and* '*How*

important is it for you to improve your physical condition?', and with a score of three or less to the question *'How satisfied are you with the way you maintain a healthy lifestyle?',* were deemed suitable for the study due to the strong fit between their interests and the value proposition of the offering.

Based on this criterion sampling, 15 participants were pre-selected and contacted by phone to corroborate their answers and interest in the study. It was during this process that we encountered problems recruiting participants for GreenWheels, resulting in the reduction of the total number of participants from 15 to 12, and the elimination of this Smart PSS as stimuli to our study. Moreover, we sought to minimize the overrepresentation of groups (e.g., male vs. female, young vs. elder). Thus, the final set of participants in Study #4 was composed of five men and seven women, who were between 25 and 60 years of age (men M_{Age}= 47; women M_{Age}= 44). However, such criterion was considered secondary to the purpose of the study and the goals towards the Smart PSS as prevailing. An overview of the final twelve participants, demographics, and selection criteria can be found in Appendix F.

Use of the Smart PSS

One month prior to receiving their respective Smart PSS, participants were sent a personalized booklet containing general information about the study. The goal of this booklet was to familiarize participants with the study set up, timeline, and types of questions and tasks. Moreover, we aimed to raise possible important questions with participants prior to the start of the study, thereby minimizing delays and drawbacks due to misconstructions in relation to the procedure. Furthermore, through this personalized booklet, participants were instructed on how to download the Contexmapp app and provided with log-in information to access the first set of questions/tasks.

As participants would share their personal lived experiences with text, picture and video, it was of great importance to create an atmosphere of trust and respect, and to encourage them to share their thoughts and feelings openly. Therefore, participants were visited at their home by the main researcher to make a personal introduction and to answer any possible unsolved questions. Furthermore, the Smart PSS was handed over in its original package, which participants could unpack at their own pace, upon departure of the researcher.

Receiving and unpacking the Smart PSS demarked the official start of the research. In the subsequent 8-9 weeks, participants interacted with the Smart PSSs and answered the questions/tasks, which they were able to unlock over time. Participants were encouraged to document only the experiences that were meaningful to them. Moreover, it was important to encourage participants to use the Smart PSS as if it were their own. Hence, during the duration of the 8-9 weeks period there was limited one-on-one interaction between the researchers and the participants. A phone call was scheduled one week after receiving the Smart

PSS to answer any possible questions regarding the clarity of the questions/tasks. Subsequent interactions took place via Contexmapp, for example, through push notifications warning participants of the need to advance to the next modules. In two cases, the Smart PSS failed to make the transition from orientation to integration and participants were unable to complete the tasks and questions given. However, their experiences were considered valuable for the study because they provide another vision on how user experiences with Smart PSSs can unfold. In these instances, participants were contacted by phone to assess the situation and inquire about the reasons for not making advancements. Once it was corroborated that participant' problems were related to their experiences with the Smart PSS (and not the research setup), they were instructed to keep the Smart PSS and to report any possible changes in their interactions with it.

Post-use Interview

At the end of the 8-9 weeks, participants were met once more for a final interview at their home. The goal of the interview was to discuss their overall experiences with the Smart PSS. To this end, a semi-structured interview was developed. This approach was deemed appropriate as it allowed addressing key subjects and keeping some structure to the discussion. Moreover, this approach provided flexibility to the researcher to explore concepts considered relevant and not anticipated previously (Patton, 2002). The interviews lasted 45 minutes on average and the audio was recorded (with participant's consent).

The interview guide consisted of four topics. First, the purpose of the interview was described to participants. Second, we aimed to find evidence for the validity of previous findings. Consequently, a second topic in the interview aimed at discussing how participants perceived the differences between Smart PSSs and single products. The goal was to attain a better understanding of participants' awareness of the system (i.e., the integration or product, service and supporting infrastructure), as well as its characteristics.

The remaining two topics were aimed at addressing the specifics of participants' experiences with the Smart PSSs. To help participants elucidate relevant experiences with the Smart PSS, two approaches were followed. First, we were inspired by the work of Kujala et al. (2011), who developed the UX Curve as a tool to help evaluate long-term experiences of users, identify their chronological order, and their influence on aspects, such as customer satisfaction and loyalty. The UX curve consists of a template with two-dimensional spaces, which signify positive and negative experiences. While the horizontal axis indicates time, the vertical one denotes the fluctuations (e.g., from negative to positive to negative again) and the intensity of this experience. Thus, the UX Curve helps pinpoint meaningful points in the experiences of users, and allows them to focus on those aspects that are truly meaningful to them.

The UX curve was partly implemented in our study to help participants become aware of the temporality of their experiences, but also of their overall satisfaction with the Smart PSS. Kujala et al follow an approach where a general UX curve is diagramed by participants, followed by four specific diagrams in relation to the attractiveness of the product or service, its ease of use, its utility and its degree of use. Given that our goal was to find commonalities in the aspects influencing the user experience among four types of Smart PSSs, it was decided to keep a high abstraction level with the curve, and use it only as a means to elucidate general meaningful experiences with the Smart PSSs. Throughout this exercise, participants were encouraged to describe the reasons for changes in their curves aloud. Figure 5.7 depicts an example of a UX Curved diagramed by a participant.

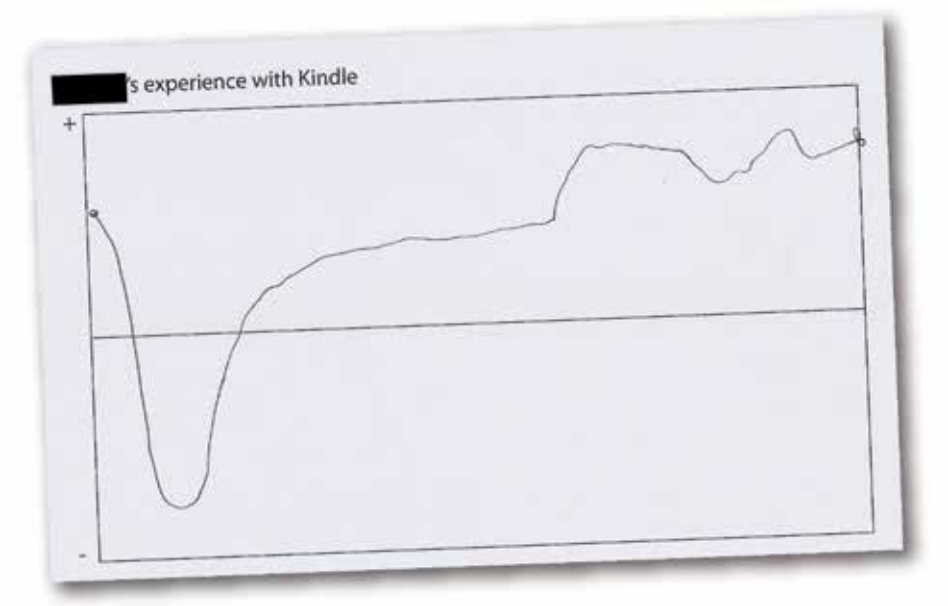

Figure 5.7 Example of UX curve by participant who experienced Amazon's Kindle

Once participants completed their UX curves, the graphs were discussed in detail in order to relate specific user experiences to ups and downs in the graphs. To this end, participants' answers to questions and tasks through Contexmapp were processed and developed into what we call UX cards (Figure 5.8). Thus, for each participant a set of cards was developed, where their number varied according to the amount of experiences participants reported. Developing the cards brought two advantages to our methods. First, it allowed the main researcher to become familiar with the data prior to the final interview, thereby identifying possible interesting topics to be discussed. Second, the cards allowed participants to easily elucidate particular

experiences, but also to relate them to specific points in time. The experience cards were laid facing up on the table, and participants were given the liberty to pick and further discuss those cards that were meaningful to them in relation to the UX curve they had drawn.

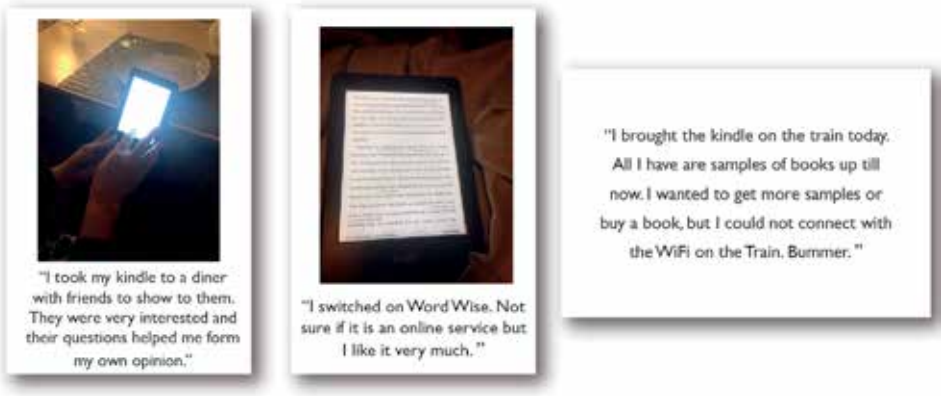

Figure 5.8 Example of UX cards used during the final interview of a participant of Study #4

Data Analysis

All in-depth interviews were transcribed verbatim using a word processor. As the final interviews covered the experiences of participants reported through Contextmapp, the data collected through this tool was deemed repetitive and excluded from the final analysis. Furthermore, the research software Atlas.ti was used as a platform to analyze the data, and in doing so, a conventional content analysis approach was followed (Hsieh & Shannon, 2005; Patton, 2002). While our study reflects on the work of Karapanos (2013) and Secomandi (2012), we opted for a more inductive, less directed approach, to guarantee the emergence of relations between codes, constructs, and themes, specific of users' experiences with Smart PSSs. This data analysis process followed different steps.

First, a set of five interviews was read line-by-line and open-coded by the main researcher. Throughout this process, notes and memos were simultaneously made, which reflected our sense making of the data. This first processes resulted in the development of 76 codes, which were organized in a codes list with corresponding examples and definitions.

Next, this initial code list was discussed in a session with the remaining members of the research team (i.e., analyst triangulation; Patton, 2002). The purpose of this session was to increase the internal validity of the study by reaching consensus

among peers regarding the interpretation of data and naming of codes. Moreover, this session led to the identification of a preliminary set of themes and constructs, used as the basis for the subsequent coding of the remaining interviews. The identified preliminary themes were four: *user experiences over time*, and *maintaining the value over time-factors influencing the continuous use* (i.e., transition from orientation to incorporation)*, definition of Smart PSSs, research methods* (i.e., in relation to evidence of how the research setup could be improved). The identification of these themes was guided by our researcher questions and previous research experiences. Furthermore, examples of constructs identified in this phase include: *coherence in-and-out of the system* (defined by codes such as 'ambiguous information can influence trust/perceptions towards companies' and 'integration with other products/services should be seamless')*, coherence of ease of use* (defined by codes such as, 'consumers set expectations based on similar products' and ease of use of installation empowers')*,* and *service attributes* (defined by codes such as, 'value of service: more personal', 'positive attribute of service: empowerment' and 'value of service: information over an extended period of time').

In the subsequent phase, the remaining seven interviews were coded. The result of this phase was the addition of 28 new codes, for a grand total of 104 codes. The final list of codes was once more discussed in a triangulation session with the research team. During the session, we identified codes that conveyed the same message, and merged them, helping to reduce the final number of codes further. Also, codes that were unrelated to any of the constructs and themes were removed from the analysis. Constructs were re-evaluated, identifying subcategories within the constructs, helping concretize the final set of themes. For example, 'coherence in-and-out of the system' was further divided into the *coherence of information* and *coherence of functionality*, to highlight their individual relevance and contributions to user experiences with Smart PSSs. Finally, themes and categories were further associated to the two research questions in this study and to Karapano's theory to form the basic structure of how our results are presented. Consequently, our results exclude the codes related to the definitions of Smart PSSs, and aspects of the research set up (the latter are discussed in the 'limitations' section of this chapter; Section 5.3). An overview of the final 31 codes, 7 constructs, and 2 themes that guide our results section can be found in Appendix G.

5.2.2 Results Study #4

The following two sections present our research findings. First, we address the subject of temporality by presenting a helicopter view of the user experience with Smart PSSs and the different steps that compose it. In the second part of the results section, we present a closer look at the factors that influence the user experience with Smart PSSs. In particular, we provide an overview of those factors that can have an effect on the orientation phase and the transition from orientation to incorporation, hence, affecting the prolonged and valued interaction with Smart PSSs.

5.2.2.1 Temporality of the user experience with Smart PSSs

In relation to temporality, we found evidence for the three user experience phases discussed by Karapanos (2013), namely, orientation, incorporation, and identification. Figure 5.9 illustrates graphically the temporality of experiences for Smart PSSs. Particularly, the figure aims at portraying the orientation phase, as well as the transition from orientation to incorporation, as the focus of our research lies in these two areas. Furthermore, our findings contribute to the work of Karapanos by indicating the several steps users go through within the two highlighted phases. Overall, our findings provide detailed accounts of the several product and service-related factors that can influence consumers' evaluation at each phase, and draw attention to the aspects that designers can intervene to maximize and prolong the meaningful interaction of users with Smart PSSs. We now proceed to describe the steps and phases in the following paragraphs.

The blue line in the figure represents the orientation phase. In our research, the first accounts of users in relation to their experiences with the Smart PSSs started while unpacking the offering (A). Already during this step, users looked for information or instructions, such as pictures in the box and instructions manuals, which could assist them while moving to the next step of installation and assembly of the Smart PSSs (B). Importantly, while installing and assembling the Smart PSS, users were often excited but also confronted with difficulties or questions related to the installation and the functioning of the smart product.

To tackle these difficulties and questions, users actively looked for information that could guide them through the installation process (C). However, compared to traditional products, information for Smart PSSs is more widespread and often found in different touchpoints and formats, such as printed manuals, websites, apps, or customer support personnel. As users were generally used to finding information in the traditional printed manual, they needed to explore and dig deeper in order to find the right information. Once information was found, most participants were able to complete the installation process, demarked in the figure as an orientation loop, and move forward in their interactions with the Smart PSS. However, looking for information was found to be critical for the user experience with Smart PSSs. When users were unsuccessful in finding the information needed, or unsatisfied about the process, they failed to advance the orientation loop and to develop their experiences further. In our study, at least three participants experienced difficulties installing the product successfully. In two of these cases, the experiences were so detrimental that they failed to install the product appropriately, ultimately affecting the transition to the incorporation phase.

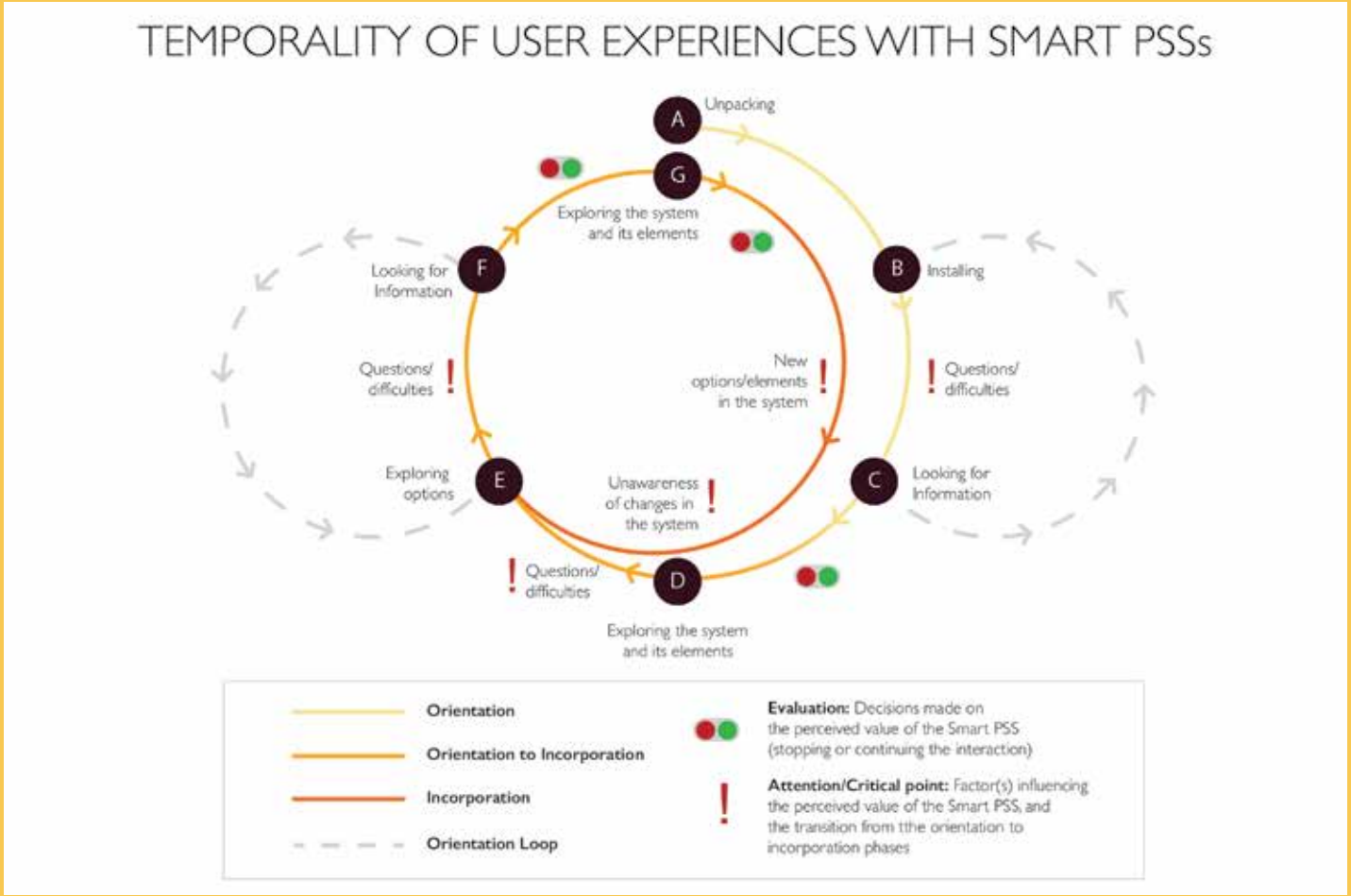

Figure 5.9 Temporality of user experiences with Smart PSSs

> "Maybe because of the missing manual. It's like you get all this cool stuff, but you really don't know what kind of other cool stuff you can do with it. What kind of options you have. That is something a bit missing for me. Could be clearer, I think"– *Hue #2*

Thus, the availability of information needed to properly install the Smart PSS influences users' perceptions towards the solution already from an early stage. Furthermore, these early experiences with the Smart PSS are important because they lead to an overall evaluation of the system. When unsatisfied, negative experiences may inhibit users to interact and explore the Smart PSS further (D), and to interact with features of the Smart PSS value proposition that could be of value to the user.

If users are successful in installing the Smart PSS, they can begin to explore the system and its elements (D), and the transition from orientation to incorporation commences (yellow line in the figure). During this transition, users still experience difficulties and have questions regarding the way the Smart PSS works. As stated throughout this thesis, users of Smart PSSs are confronted with one or more tangible devices, and one or more digital interfaces (i.e., websites, apps) that together form the Smart PSS. Moreover, Smart PSSs are often part of an eco-system of products and services (i.e., other Smart PSSs that can be purchased) that offer complementing value/experiences to users. Thus, an important aspect for the transition from orientation to incorporation is the understanding of the different touchpoints composing the solution, their relations and differences.

> "Yeah, so this was more in the beginning, where all the different products confused me [what] they offer. Not which one I had, but whether I needed something else to actually track my sleep." –*Aura #3*

Furthermore, different from traditional products, Smart PSSs offer a wide range of value-creation options within the same system, such as diverse functionality, content, and information (See Chapter 3), and their exploration (E) was found to be a critical part of the transition from orientation to incorporation. Echoing the results of Karapanos (2013), we found the actions of exploring new options and functionalities to be motivated by the novelty of the Smart PSS. Participants were excited about the new product, and curious about the potential impact to their lives. This curiosity, in turn, translated into a drive to explore the system through and through.

> "Well the goals in the beginning were also about seeing all the different kinds of possibilities that the product had and I think by now I know what the possibilities are and what the things are that I actually use. So, I use the step-counter and see how many activity I had during the day and the calorie counter and I like the stair-counter as well. So those are the things I really use and the watch function.

> I love the watch function. It's very good to have that in there. So it comes from discovering everything that's possible to just using it in your everyday life." *–Fitbit #2*

However, users had questions regarding the differences between options and how to access them. Because options are wide ranging, users were often overwhelmed by the alternatives and experienced difficulties understanding the value that they brought to them. To solve their doubts, users relied on different sources of information, such as information provided by the supplier and the experiences of other users (F). This process of exploring and understanding the options is demarked by yet another orientation loop in the graph (Figure 5.9, left circle). This loop can occur as many times as needed until the user is ready to use the Smart PSS in a more routinely way. Thus, the process of exploring and understanding of options is critical because it determines how easily users can access options that are right for their needs (see Section 5.2.2.2). Users that do not find the right options question the value of the system, their perceptions towards the solution can alter, which leads to potential unwillingness to explore and interact with the Smart PSS further.

Once users start to use the Smart PSS regularly (G), they can make decisions on whether to incorporate the system in their lives. Users have the opportunity to experience the Smart PSS in relation to their individual goals and to assess whether the chosen options fit their individual needs (i.e., incorporation, orange line in Figure 5.9). Moreover, users go through a process of *trial and error* to understand the limits of the Smart PSS. Users put the claimed attributes of the Smart PSS to the test, even when they do not relate to the value they seek in the offering. For example, in quantified-self devices, users typically test the information provided by the system in relation to their activities, aiming to assess its accuracy and constancy. This trial and error process helps consumers to define the trustworthiness of the system, thus, influencing the perceived value of the offering:

> "I think when I look at the sleep data of the last few weeks, it looks all right. You never know, I mean, the sleep cycles of "deep sleep" [and] "light sleep", I'm asleep. And "being awake" of course, being awake I'm mostly conscious […] But at least the ones waking up during the night I remember mostly. And if I did look at the clock it seems to fit with my impression on my sleep." *–Aura #1*

An important difference between traditional products and Smart PSSs is the opportunity the latter offers to adjust the value proposition to one's needs (Chapter 3). As users get used to the value proposition, or the novelty diminishes, their engagement and enjoyment of the system can also diminish; ultimately influencing the way users interact with it. However, companies can introduce new options or elements in the system. This aspect is considered critical because it gives consumers

the possibility to readjust the system to their changing needs, and gives companies the possibility to reconnect with them. Furthermore, we see this trait of Smart PSSs as creating a cycle in the way users explore and interact with the Smart PSSs. Users will go back to the orientation steps, looking for information, exploring and experiencing new options (E, F,G). This cycle may be repeated over time so long consumers remain engaged with the system and continue to renew their value proposition. However, users need proper guidance to make them aware of new additions, to understand how the changes in the system affect their experiences with the Smart PSS, and the value they derive from the system. Failure to manage this step can result in lack of orientation toward new options, and a missed opportunity to reinforce the incorporation of Smart PSSs into consumers' lives.

In sum, it can be concluded that the temporality of user experiences with Smart PSSs is characterized by a prolonged and cyclic orientation phase. In this regard, Karapanos reports satisfying and dissatisfying episodes related to the orientation towards a product (i.e., the iPhone) as dropping considerably after the first week of use (2013, p. 73). Conversely, for Smart PSSs this orientation process can last several weeks and continue through the incorporation phase, and for as long as the user redefines the system by incorporating new elements and options. In our study, at least one participant claimed needing more than the 8 weeks provided by the study to comprehend the system, its options, and the value it represented. We attribute this (extended) needed time to characteristics of Smart PSSs of continuous growth, which drives users to explore the system little by little, and to the multi-touchpoint nature of Smart PSSs, which diverts the attention from one single unit of interaction (and value creation) to multiple ones.

> "I'm very happy that the investigation took two months, and maybe in the future it also could take three months, because now I'm at a point that I'm actually starting again. I know so much about it, but I have to rearrange and make the next step, and I have the feeling that I'm now in the middle of something that I touched, but now I have to work on using the product in a certain way and find out what's important to me." – *Hue #3*

Furthermore, while outside the foci of this study, it is worthwhile mentioning the evidence we found in relation to the *identification* of users with Smart PSSs. Echoing the findings of Karapanos (2013), the smart product, often in combination with the e-service, influenced the interactions of users with others around them. Participants were generally excited to show off the Smart PSSs to family and friends, and reported several experiences were the Smart PSS incited conversations and activities with family and friends.

> "I tell friends: come and eat. [They] are very curious about it and I explain how the app works and they're very flabbergasted about the... You can use your app

and the light follows your instructions and it goes as well, so they like it very much." –*Hue #3*

We speculate the *identification* with the Smart PSSs to play a role in the transition from orientation to incorporation, serving as a driving force to continue exploring the system, and determining the system's value in relation to one's needs. Our conjuncture is that the identification with the system will strengthen the extent to which users engage with the Smart PSSs, playing a role in user's willingness to renew their value propositions.

Factors affecting the transition from orientation to incorporation

By the time the research was concluded, most of the recruited participants had incorporated the product in their lives and were using them to varying regularities according to their individual needs. For two participants the Smart PSSs failed to transcend the early orientation phase. In both instances, participants were unable to find relevant information, to install the system (points B and C in Figure 5.9), and consequently, to explore and meet their personal goals towards the Smart PSSs.

While most Smart PSSs succeeded to get incorporated into consumers' lives, we had several reports of experiences affecting the continued and recurrent use of the Smart PSSs, and the transition between phases. These reports led to the recognition of several factors, which showed to have positive and negative effects on user experiences with Smart PSSs. Consequently, the purpose of this section is to discuss these factors in detail; pinpointing specific aspects that designers can intervene to better manage the transition through steps. These factors are aggregated into the following four groups (Table 5.3): 1) quality of information 1) number of options offered by the system, 2) coherence of functionality, and 4) product attributes.

Quality of Information

Due to the complexity of the Smart PSS, such as the diversity of touchpoints and large number of options, quality of information played a particularly important role for triggering positive and engaging user experiences with Smart PSSs. Throughout the orientation phase, as well as the transition from orientation to incorporation, participants had detailed questions related to the functionality of the solution. For example, they had questions on how to install the different elements forming the Smart PSS, the technology behind the smart product, and the differences in features between different touchpoints in the system.

"I am missing information on how they think they achieve this. How the light… when does it start waking me up and based on which factors does it wake me up at that time. And I haven't Googled for it, so it might say so in the product information how it does that. But somehow I don't Google it, because I don't have faith that it will actually be there. So I go like, well I will figure this out on my own." –*Aura #3*

Table 5.3 Factors affecting the transition from orientation to incorporation of Smart PSSs

Factor	Feature	Relation to steps in orientation phase	
Quality of information	Accuracy of data Coherence of information (completeness, clarity of information across different touchpoints/means) Format/way in which information is presented	A B E G	Unpacking Installing Exploration of options Exploration of the system and its elements (use of Smart PSS)
Number of options in the system	Number of options offered Openness of the system (possibility to access options offered by third parties)	E G	Exploration of options Exploration of the system and its elements (use of Smart PSS)
Coherence of functionality	Synergy between different touchpoints (how well different elements connect/communicate) Integration with third party products and services Performance of other technologies facilitating the use of the Smart PSS (e.g., WiFi) Ease of use	G	Exploration of the system and its elements (use of Smart PSS)
Product attributes	Tangible attributes of smart product (e.g., material, weight) Attributes related to products' functionality (e.g., sounds, lights vibrations, battery life)	G	Exploration of the system and its elements (use of Smart PSS)

Thus, users of Smart PSSs require information that supports their orientation process, and positively reinforces the experiences with the system. In our study, quality of information was facilitated by the accuracy of information (in terms of

data), the coherence of information through different touchpoints, and the format/way in which information was presented to users.

In quantified-self devices (e.g., Fitbit, Withings Aura), in particular, data that was measured through the smart product (which is the basis for the development of knowledge to users) was perceived to be relevant when accurate and closely mirroring reality. Users wanted to understand how the data was obtained/calculated, and put the solution to the test to make sure their data is meaningful. As seen from the example below, this type of accuracy is associated with the well-functioning of the system, and has an impact on the value and trust placed on the offering.

> "This was very important… it is the same aspect I didn't like about it. If I go roll skiing and Fitbit says I walked 111stairs, then the thing doesn't work." *–Fitbit #1*

Moreover, participants were expecting complete/detailed instructions manuals available inside the package, as often found in singular products. However, for Smart PSSs, instructions available on both the packaging and the printed manual were limited. Instead, Smart PSSs frequently follow a plug and play experience. Relevant information could be found in digital format over different touchpoints (e.g., e-service, web portal). Moreover, the completeness and extent of information varied through touchpoints.

> "That was very unclear. So I didn't even know how to turn it on at first [...] I really thought there would be something here […] There is nothing, there is no information…the booklet is not clear to me anyway. I sort of thought it was your idea to challenge the user, just to give no information and figure it out by yourself." *–Kindle #1*

Thus, the incoherence between expected and actual availability of information creates ambiguity for users and is detrimental for the initial steps of the orientation phase. The example below illustrates one such case. The quote relates to a user of Withings Aura, who encountered issues during the installation the smart product. The participant, who was at the time trying to install Within Aura, followed the instructions available in the packaging, and used the illustrations on the packaging to support such process. However, the quality and extent of information in those two means were not the same. The illustrations (pictures) were incoherent with the information written on the instructions (i.e., they did not correspond), ultimately leading to confusion, frustration and a complete interruption of the use of the Smart PSS:

> "And it also says here for example: "sensor on the mattress". But it is actually under your sheet. You see [pointing at picture on box illustrating sensor location],

> here it is above the mattress. And on the sheet on the instructions it says: on the sheets. Mattress for me is where you sleep on and then you have your bed leaner, because I was thinking: "How do you put this under your mattress" […] And then, after I thought about it and that is a bit strange to put it under your mattress. Because that sensor would not feel anything." –Aura #2

Offering multiple options (e.g., content, features) can be positive for user's experiences with Smart PSSs (see following section). However, options become detrimental when users are not properly guided. Particularly in early orientation interactions, the large set of options caused some participants to feel overwhelmed. Thus, part of guiding users through the orientation phase is deciding in which format/way options are presented, in a way that has meaning. As options can be developed for users with varying needs, or varying configurations of the Smart PSS, it is important to provide clarity on the differences between them, to facilitate the search and discovery of options that will fit users' individual context/needs. The example below exemplifies the difficulties users can encounter while exploring options. The user of Philips Hue found insufficient guidance when looking for new options for the Smart PSS. Options in this particular case related to different "scenes" or "moods" that could be created with the colours of the lights. There is a large community platform where users can upload their created scenes and share them with other users. When looking for these options, this user could not filter the options according to the number of lights she owned, finding disappointment every time she chose one:

> "You know, it's difficult sometimes. Sometimes you find a scene and you think ok let's try this one and then after you click it you see it is for 7 bulbs and I'm like well I only have 3 and it doesn't work. So the joy gets off a bit. So it's like hmm ok, next one. So that is a bit…less fun... Because I did try it a lot. And after that I stopped trying. I haven't used this in a while really. I did start making my own though, that's nice."–*Hue #2*

To conclude, the accuracy of the data and the format in which information and options are presented to users can have an important impact on how users derive value from the Smart PSS. Moreover, in our study, users had different needs regarding the detail of information they required to derive value from the Smart PSSs. Such expectations should be clearly defined a priori by designers, to present the correct type of interaction with the system.

Number of options offered by the system

As shortly discussed, the number of options offered by the system is an aspect influencing the user experience with Smart PSSs. Consequently, the goal of the present section is to elaborate further on this factor and how it can positively or negatively influence users' experiences.

First, options in the system related to content, such as books or personal data (e.g., measurement of sleeping patterns), but also to the integration of the Smart PSS with other services and products (see coherence of functionality). Options, as anticipated in Chapter 3, had a positive effect (or negative when lacking) on empowerment. For example, in the case of Amazon Kindle, some participants felt restricted by the system when not being enabled to read e-books provided by different suppliers or the local libraries. As our participants were avid readers, who also borrow books as part of their reading routines, they felt that this inability hampered their overall experience with the Smart PSS. Moreover, in relation to the integration with other services, participants referred to an open system, one where third party developers can contribute with content or services, as generally desirable. The reasons behind this appreciation is the broadened possibilities to find options that fit the individual needs of consumers, thereby contributing to their feeling of empowerment:

> "Now… The service. I don't like it when there is a monopolistic service. That you have to use that one. It's not an open page, where others also can go on. That I don't like…because then you must and when you must something I don't like it." *–Kindle #2*

Furthermore, options facilitated the orientation phase of participants by providing a platform to test the Smart PSS, helping users to find attributes, content, or services that appealed and were valued by them. Moreover, participants were aware of their diminishing engagement with the Smart PSS, as the novelty of the product wore off. In this regard, the continuous growth of the system (i.e., the recurrent introduction of new content and features to the system), was recognized as a desired aspect, one that helps users to stay engaged with the Smart PSS in the long term:

> "I can imagine that in the future I might disconnect the sleep sensor and just use it as a wake-up device. It depends on what features they develop and I think things like the sound level and so on might keep me interested. So I think new features, new useful features would certainly keep me interested." *– Aura #1*

Coherence of functionality

The well functioning in the interaction of the different touchpoints of the Smart PSS (e.g., webportals, e-services), and possibly different smart products (e.g., wearable sensors and stand-alone devices), is an important factor to create positive experiences with Smart PSSs. We identified several aspects that can influence a coherent functionality.

First, the perceived quality of the functionality of the Smart PSS is affected by synergy between different touchpoints, which can affect how digital content, data

or information is timely and accurately transmitted from smart product(s) to e-service(s), or shared across different touchpoints. For example, in the case of Fitbit, the transmission of measured data from the wrist sensor to the e-service was described as being seamless, and having a positive weight over negative aspects of the user experience:

> "Even though I have complained about certain aspects that I don't think the website did right, something that was actually very good was the way the product and the website synched with one another, and that seamlessly. I never had a problem synching data between the two. So I think they have done a really good job there, in making sure that the two work together." –Fitbit #2

Another example illustrating how synergy between touchpoints can affect functionality, and thus, the user experience, can be found in Philips Hue. While used by a household of several members, the system struggles to recognize commands from different controllers; mobile phones belonging to two different members of the same family. Geo location is an option that allows the system to recognize when a user is within a certain range, turning the lights on/off automatically. However, if one member leaves the house while the other one stays, the system does not recognize that someone has stayed, and the system behaves incoherently:

> "I started working with the Geo location, but, and that's the part of here: the negative part. The train station is pretty nearby with the train track. And when my girlfriend [would] come home using the train and she had the Geo fencing on… [and] she past [near] the house, everything switched off, because she was out of the Geo fence. So it's, actually I think the product is designed for only one-person household. Because if somebody was around the house and had the light switched one, the Geo fencing didn't notice him or her. So if somebody else was leaving, everything switched off." – *Hue #1*

Furthermore, the perceived quality of the functionality of the Smart PSS is affected by how well it integrates with third products and services. Some Smart PSSs provide open and semi-open platforms, and encourage users to connect the Smart PSS to other products/services to enhance the user experience. While this tactic is generally perceived as positive, the integration with other devices or e-services needs to be effective and seamless, guaranteeing the proper functionality of the Smart PSS:

> "When I set up the account they also said you might want to connect to your Garmin account if you have a Garmin watch, which I do, because that product is much more accurate when you are exercising […] then it turned out that the kilometers and steps that are recorded using Garmin don"t count towards the badges […] but I thought that was so strange because you have a whole process

of linking the two and they say when you do that you get silly numbers in your account." *–Fitbit #2*

Furthermore, the coherent functionality of Smart PSS can be influenced by good performance of other technologies facilitating the use of the Smart PSS. For the participants taking place in the study, the correct functionality of the WiFi connection was in more than one occasion a limiting factor, having, in some cases, direct consequences for the recurrent use of the Smart PSS:

> "And I tried [the lights] in the bedroom as well, because I wanted like a sunset [scene]. To wake up with a sunset... But the WiFi signal isn't strong enough, so I have to put something [a separate device] in between." *–Hue #2*

Finally, coherence of functionality and the quality of information contribute to the easy of use of the Smart PSS, and consequently, to its incorporation into consumers' lives and continued use. Ease of use played a particularly important role in the early steps of the orientation phase. Therein, ease of use relates to making the installation process intuitive and pleasant for the user. Furthermore, ease of use can affect the effective search of options in the system. A particular example is Kindle. Kindle allows users to access and purchase books directly through the e-reader (i.e., smart product). However, this process was considered cumbersome by participants, who expressed difficulties finding the desired content through said platform, opting instead to buy books through the website via a computer. Although also a possibility, it is clear that one of the core attributes of the Kindle, which is content through the device, is not meeting the expectations of some users.

> "The service itself is okay. Is just that it's so sluggish, you know. It's not very nice to find a book on the Kindle. Unless you are somewhere and you have nothing else to do, then it is really nice that you can [buy books with] the WiFi." *–Kindle #3*

Importantly, ease of use facilitates the *empowerment* of users. Empowerment was identified as an important characteristic of Smart PSSs (Chapter 3), which gives control to users, allowing them to take action and at their own time and pace. What this research shows is that feelings of empowerment already start at an early phase in the user experience of Smart PSSs, with important implications for the first impressions of users towards the system:

> "The fact that I was able to make the installation in half an hour, makes it quite easy, and that gave me the strength to use it, and during the process I see that that works, and that works and that works. I also used different kinds of apps, and I looked at the site, and all these little stones were fitting in nicely so it makes it comfortable and makes it nice to use so you don't have to worry any more that I

locks or it breaks down or it doesn't function anymore." –*Hue #3*

Product attributes

Finally, similar to traditional products, product attributes in Smart PSSs were often referenced as important contributors of the experiences of users, both positively and negatively.

First, general aspects of the tactility of the product, such as the weight of the device, and the feeling of the material to the touch, were seen as important. Cases where these attributes played a particularly important role related to Smart PSSs whose users' interaction with the smart product was frequent. For example, for wearable and portable devices, such as Fitbit and Kindle.

> "That may be strange, but I like the rubbery, rubber feel of it? Is it important? Well you have it all the time in your hands, so it should feel smooth and nice. And it does that. So I liked that about it. So this is well sort of important." –*Kindle #3*

In Fitbit, for example, participants paid particular attention to the material of the wristband. As participants are meant to wear the wristband at all times, in order to measure their activity throughout the day, the material was expected to feel comfortable and not irritable to the skin. Furthermore, as the Fitbit is likely to be used in moments of high physical activity where sweat is involved, participants brought up the issue of whether the wristband is easy to clean as a relevant concern.

Second, other characteristics of the smart product related to the functionality of the smart product, such as sounds, lights vibrations, battery life, Wi-Fi connectivity, were mentioned as influencing aspects. In our study, we found instances where these attributes had both positive and negative effects on the interactions and experiences of users with the Smart PSSs. An example of a positive experience relates to Withings Aura. One of the smart devices of the Aura is a nightstand lamp, whose light slowly dims and emits relaxing sounds when users are set to sleep. The participant in the quote below had troubles falling asleep easily. In this case, light and sound helped him reach sleep more easily, thereby contributing to his sleep-quality.

> "I thought this light and the music that you had the slowly decreasing volume of the music. It is a kind of conditioning yourself to sleep, which I think is useful. And then the waking-up in the morning, especially in the winter time with the slowly coming up of the light makes it for somewhat more gently experience than just an alarm clock, when it goes off. And this I found really pleasant. I hadn't expected this but this I found very pleasant." –*Aura #2*

Examples of negative experiences include those where the product affected

the activities of the participants or those around them. For example, two of the participants of Withings Aura complained about the humming noise the lamp made, especially at night, which conflicted with their goals of achieving a better sleep. In such cases, the participants not only were concerned about their own sleep but that of their partners. Another example relates to Fitbit, which enables users to connect the Smart PSS to the phone, to be notified via vibrations in the wrist about incoming phone calls. In such case, the feature was perceived to be exciting but turned to irritation relatively fast:

> "I mean, I started using it as a watch. I turned off the functions of having phone calls connected with vibrations on my wrist. Because that was really annoying me. The first three times I got a phone call, I thought, hey! that's nice…[until the] fourth and fifth times. And I mean I get about 10-15 phone calls a day. And if I hear my phone ringing and I pick it up and then one second later my arm starts twisting. The Fitbit is too late and then it's annoying. So I disconnected that."– *Fitbit #1*

5.3 Overall Discussion and Conclusion

As discussed in Chapter 2 (section 2.3.1), user experiences with Smart PSSs were expected to be influenced by the interrelation of situational aspects, intrinsic aspects, and the characteristics of the Smart PSS (see e.g., Hassenzahl & Tractinsky, 2006; Sandström et al., 2008). Our research echoes this conjecture, and demonstrates that perceptions and evaluations of Smart PSSs are influenced by the interactions of the user with tangible devices, but also with the digital interfaces and other touchpoints that support the system. While the digital interface is a key aspect of the experiences of users with Smart PSSs (Secomandi, 2012), designers should give as much relevance to the tangible elements of the system. As demonstrated in Study #3, and further in Study #4, users evaluate the Smart PSS in an integrative manner, making use of the difference cues available to them (Shostack, 1977).

Smart PSSs are composed of different elements or touchpoints, which together strengthen the value proposition to consumers. This multi-touch characteristic can pose an important advantage to companies implementing Smart PSSs. For example, by addressing different user needs through different touchpoints/elements that hold different characteristics. However, our results show that the diverged attention of users to multiple elements can represent a challenge to their understanding of the solution; of the conjoint value that these different elements deliver. The different manners in which elements in a Smart PSS are integrated have thus important consequences on how consumers experience the solution. Designers must be mindful of the characteristics and expected value to be delivered through each individual element. Yet, designers must consider the interplay of elements within the system, and

how such interplay influences the experiences and perception of users over time.

Moreover, this chapter has allowed us to attain a better understanding of user experiences with Smart PSSs over time. User experiences with Smart PSSs are more complex (as described above) and dynamic than discrete products. We found evidence for the three phases in the temporality of users' experiences, namely, *orientation*, *incorporation*, and *identification* (Karapanos, 2013). However, our findings portray user experiences that are cyclic. The orientation towards the solution can extend over several weeks. Often, users need a prolonged period of time to comprehend the boundaries of the Smart PSS; to be aware of the elements that compose it, way of working, options offered, and to define the value the system brings to them. Also, the orientation phase can be reoccurring, for as long users engage with the Smart PSS. As new options (i.e., touchpoints, services, content) are incorporated in, users explore these options and reenter the orientation phase, in order to understand and assess the significance of those new options to their individual needs.

Furthermore, different factors and critical points were highlighted through this chapter. These factors and critical points are important because they represent specific stages in the user experience that designers can manage to maximize the experience of users; in order to create more positive and meaningful experiences for users of Smart PSSs.

First, critical experiences with Smart PSSs start at an early phase in the temporality, when users unpack and install the solution. In this stage, it is of great relevance to provide users with complete and coherent information to set them in the right direction; to continue exploring the Smart PSS with a positive mindset. While a plug-and-play experience goes hand-in-hand with such types of high-tech products, we advise designers to not disregard the more traditional printed manuals to help users get started. In our study, several of our participants expected this type of information to be at hand, and struggled to install the system when absent. As Smart PSSs gain terrain in the market, we can expect a larger number of non-tech savvy's to adopt these types of systems. Thus, designers will encounter the challenge of making the first steps of the user experience intuitive and user-friendly for a wider range of users.

Second, one of the strongest assets to creating meaningful experiences with Smart PSSs is the multitude of options that users can access to fine-tune the value proposition to their individual needs. However, when not properly managed, the wide-ranging number of options complicates and has a detrimental effect on the interaction of users with the system, and becomes an important threat. Designers can help users to understand the system by creating awareness of the different elements and options it includes, but especially, how they differ/relate to each other. Overall, providing information of good quality (i.e., accurate, coherent across touchpoints, and in a format that is meaningful to users' experiences) is key to triggering positive responses among new users.

Third, changes occurring in the system over time are a distinct characteristic of Smart PSSs with possible positive effects on the engagement of users with the system. However, such changes may not always be apparent or understandable to users. Designers of Smart PSSs can tackle this aspect by providing users with targeted information on significant changes in the system, such as new options or elements that fit their individual needs. Achieving a full picture of the system and how it changes over time is important because failure to understand the relations within the system can obstruct users from using the system as intended and reduce its potential to creating meaningful and valued experiences.

Finally, Secomandi's work on the service interface played a particularly important role in our preconceptions of user experiences with Smart PSSs (Section 2.3.3). Consequently, the present study complements the work of Secomandi (2012) by broadening the understanding of the experiences of users with Smart PSSs for a wider range of offerings. Our particular goal was to identify aspects influencing the experience of users that can guide the work of designers across different development contexts. Furthermore, by focusing on the transition from orientation to incorporation, we were able to pinpoint critical points in the user experience that can lead to the interruption or continuation of the interaction with the system. Our approach allowed us to further understand the characteristics of Smart PSSs identified in Chapter 3, and to provide designers with insights on how to trigger positive reactions among users.

Limitations

We attempted to create a research set up where participants could develop a real relationship with the Smart PSSs. We sought to recruit participants with a true interest/goal towards the tested Smart PSSs, thereby maximizing the validity of findings. Furthermore, given the complexity of Smart PSSs, it was important that participants interacted with the Smart PSSs for an extended period of time, in a uncontrolled setting, at their own context and at their own pace. While this qualitative, longitudinal approach provided us with rich information, and a better understanding on how user experiences with Smart PSSs evolve over time, it also posed some limitations to our findings.

First, users typically go through a prepurchase phase, where they search for relevant product/service information, which influences their purchase decisions (see e.g., Schmidt & Spreng, 1996). While participants in our study might have gone through such a process, their experiences were only documented from the moment they received and unpacked the Smart PSS. Thus, our research set up did not account for the amount or type of information reviewed before the study, or its influence on the formed expectations towards the studied solutions. Moreover, relevant information related to the Smart PSS was placed in the questionnaire, and a link to the Smart PSS website added. However, not all participants appeared to have

reviewed this information. Consequently, while participants' goals for testing the Smart PSSs remained true, some participants appear to have overlooked potentially relevant information regarding the Smart PSS, which could have influenced their final purchase decisions. For example, a participant indicated that, had he known the Fitbit's system was closed to third party developers, he would have chosen a different solution.

Second, our initial goal was to also test an ownerless Smart PSS. Product ownership is often discussed as an important variable in the traditional PSS literature, and was identified in Chapter 3 as an important characteristic of Smart PSSs. Therefore, it was important to include it in our study to better understand how ownership of the smart product influences experiences with Smart PSSs. Unfortunately, finding participants to test this type of Smart PSSs was unattainable, with participants expressing concerns for aspects, such as contracts and other liability issues. Consequently, further research is needed, which is focused on these types of Smart PSSs, both product oriented and results oriented, to better determine differences in the facets that affect the user experiences. Relevant questions for this research include whether there is an incorporation phase at all, and what aspects affects it. Moreover, our advice for future research centered in these types of Smart PSSs is to recruit participants directly through the provider (i.e., real clientele), who are willing to invest in the process of acquiring the Smart PSSs (e.g., contacting providers, signing contracts).

Image source: Personal archive

6. Final comments and design guidelines

The research outlined in this thesis was initiated with the aim of providing designers with insights and guidelines that could assist them in the design and implementation of Smart PSSs. The research was born in light of the limited available information on Smart PSS design. As the number of Smart PSSs in the market place continuous to rise, reports from practice and anecdotes from consumers suggest important ambivalences in these solutions. Smart PSSs undoubtedly deliver benefits to consumers. However, they often bring about undesired interactions with important detrimental effects for the value consumers derive from them.

Consequently, the main contribution of this thesis is the broadened understanding of Smart PSS design, which can support designers in the development of meaningful value propositions. To achieve our research aim, two particular perspectives were followed. First, we investigated the *aspects influencing the design and definition of Smart PSSs during the development phase*. Regarding this perspective, two topics were addressed: the 'characteristics of Smart PSSs', and 'the Smart PSS design process'. These topics were further translated into two research questions that guided our efforts:

> ***What set of design characteristics can designers use while defining Smart PSS value propositions? And,***
>
> ***How can designers support the design process of Smart PSSs?***

The second defined perspective is the *effect of design decisions on consumers' experiences with Smart PSSs*. Concerning this perspective, one topic and one research question were addressed. The topic was defined as 'consumers' reactions to Smart PSSs'. The research question was stated as follows:

How can designers trigger positive consumer responses with Smart PSSs?

Furthermore, several sub-questions were identified for each topic, which further defined the scope of the research project. Accordingly, research questions and sub-questions were investigated by means of four qualitative and one quantitative studies. These various studies, reported as empirical chapters throughout this thesis, are summarized next.

6.1 Overview of key finding per empirical chapter

Chapter 1 and Chapter 2 consisted of an introduction to this thesis and literature review, respectively. Chapter 3, Chapter 4 and Chapter 5, presented the different empirical studies addressing our research goal. Each chapter addressed a specific topic, research question and possible sub-questions concerning the perspectives previously discussed (Table 6.1). An overview of these empirical chapters, corresponding questions and main findings is presented in this section.

Chapter 3: Characteristics of Smart PSSs

Chapter 3 had the goal of addressing the following research question (no sub-questions were stated): What set of design characteristics can designers use while defining Smart PSS value propositions? To this end, two qualitative studies were conducted: Study #1-a and Study #1-b.

Through these studies, seven characteristics of Smart PSSs were identified: 1) consumer empowerment, 2) individualization of services, 3) community feeling, 4) individual/shared experience, 5) product ownership, 6) service involvement, and 7) continuous growth. These characteristics can be shaped in various ways, through various features. For example, individualization of services, which relates to making consumers feel important by addressing them as unique individuals, can be achieved by facilitating the identification of individual consumers and the use of digital servicescapes that facilitate direct communication between consumers and service providers. An overview of the characteristics, detailed descriptions and examples can be found in Table 3.1 (page 87). Importantly, the characteristics of Smart PSSs can be used when defining Smart PSSs at different levels of abstraction, and for different goals during the design process (Joore & Brezet, 2015). For example, the characteristics can be used among designers to define the specifics of individual elements in the system (e.g., features in the e-service). However, the characteristics can also be

Table 6.1 Overview of chapters according to perspective, topic and research questions

Perspective	Chapter	Topic	Research Question	Studies and sub-questions
Aspects influencing the design and definition of the Smart PSS during the development phase	Chapter 3	Characteristics of Smart PSSs	What set of design characteristics can designers use while defining Smart PSS value propositions?	**Study #1-a and Study #1-b:** No sub-question
	Chapter 4	The Smart PSS design process	How can designers support the design process of Smart PSSs?	**Study #2:** 1) What are the elements of the Smart PSS design process? 2) What are the challenges of Smart PSS design? 3) What are the designer role/contributions that help tackle design challenges?
Effects of design decisions on consumers' experiences with Smart PSSs	Chapter 5	Consumers' reactions to Smart PSSs	How can designers trigger positive responses with Smart PSSs?	**Study #3:** What is the effect of coherence between products and service elements on consumers' evaluations of Smart PSSs?
				Study #4: 1) How do consumers' experiences with Smart PSSs develop over time 2) What factors should designers consider when defining user experiences with Smart PSSs?

used during group discussions among stakeholders, on aspects that can influence the system as a whole and its implementation (e.g., business models, which have a more strategic character; see Section 2.2).

Chapter 4: The Smart PSS design process

Chapter 4 focused on the following research question: How can designers support the design process of Smart PSSs? To this end, the chapter followed three specific sub-questions: 1) What are the elements of the Smart PSS design process? 2) What are the challenges of Smart PSS design? And 3) What are the designer role/contributions that help tackle design challenges? These sub-questions were addressed by means of a qualitative approach reported as Study #2.

We found the design process of Smart PSSs to have much in common with that of traditional PSSs, but also to display distinct differences. Smart PSS design can be described as involving a *large number of stakeholders* with varying needs and goals towards value propositions (an element characteristically acknowledged for traditional PSSs). Furthermore, Smart PSS design is highly *context dependent*. It was shown that context has a large influence on the definition of the value proposition. Single Smart PSSs are typically developed to answer the needs of a wide array of consumers with varying needs. Thus, context in Smart PSS design is what helps define the value propositions for different users. Moreover, the multi-touchpoint nature of Smart PSSs provides designers with *broadened design options* on how to define and implement the Smart PSS value proposition. Smart PSSs are *ever-growing, ever-evolving*, and this dynamism is translated into a design process that is ongoing.

Furthermore, we found the above elements to lead to seven challenges of Smart PSS design: 1) defining the value proposition, 2) maintaining the value proposition over time, 3) creating high-quality interactions, 4) creating coherence in the Smart PSS, 5) stakeholder management, 6) the clear communication of design goals, and 7) the selection of means and tools in the design process. Importantly, these challenges are rooted in one or more elements of Smart PSS design outlined above. However, we found the broadened design options of Smart PSS design, and the ever-growing nature of Smart PSSs, to be particularly distinct of this development context, and to create a complexity in the design process that can be overwhelming for designers.

Finally, our findings point to five roles/contributions that are being used by designers to tackle design challenges while supporting the Smart PSS design process. Namely, designers were described as: *1) guardians of user experiences, 2) foreseers of future scenarios, 3) integrators of stakeholders needs, 4) problem solvers,* and *5) visualizers of goals*. We found the identified roles/contributions to belong to the set of design skills long discussed by the design community, and to be effective in dealing with the above challenges. These insights lead us to conclude that the current skills set of designers contributes to dealing with the complexity of the Smart PSS design process. However, designers, and particularly novice Smart PSS designers, should be

made aware of the distinct elements of Smart PSS design and the design challenges likely to be encountered, so that they can be better prepared and use their skills more effectively.

Chapter 5: Consumers' reactions to Smart PSSs

The overall aim of Chapter 5 was to investigate the third research question outlined in this thesis: How can designers trigger positive consumer responses with Smart PSSs? This question was investigated by means of two distinct studies: Study #3 and Study #4.

The aim of Study #3 was to address the following sub-question: What is the effect of coherence between products and service elements on consumers' evaluations of Smart PSSs? To this end, an experimental study with consumers was conducted. The effect of coherence was studied by manipulating the symbolic meaning 'professionalism' of a product (i.e., image of a car) and service elements (i.e., service description, image of service employee) of a fictional rental car solution. Importantly, incoherencies between product and service elements were anticipated to look unreliable in the eyes of consumers, resulting in a negative effect on their evaluations of the Smart PSS. Our results validate this assumption and indicate that consumers value the presence of coherence in Smart PSSs. By creating coherence between the elements of the Smart PSS, designers can help evoke assurance with consumers, which will positively affect their evaluation of the overall offering.

The aim of Study #4 was to address the following two sub-questions: 1) How do consumers' experiences with Smart PSSs develop over time, and 2) What factors should designers consider when defining user experiences with Smart PSSs? To answer these sub-questions, a longitudinal, qualitative research approach was followed. Study #4 was analyzed around the work of Karapanos (2013), who identified several relevant phases in the temporality of users with products. Our continuation to Karapanos' work consists of studying temporality for offerings that integrate both products and services. Our work details the early phases on the user experience with Smart PSSs, namely orientation and incorporation, by describing several steps consumers go through in each phase. Furthermore, by identifying the factors affecting the user experience at different steps, we provide designers with insights that can help them take better action to manage the user experience, and trigger specific interactions.

Overall, users' experiences with Smart PSSs were found to be complex and cyclic. The multi-touchpoint nature of Smart PSSs was found to be a pressing element on how users' experiences develop. The variety of elements in the system can complicate the understanding of the value proposition of each touchpoint, but also of the Smart PSS as a whole. Thus, the early orientation of users towards Smart PSSs consists of understanding how the system functions, how different elements/touchpoints differ/relate to each other, and filtering options that are right for their

individual needs. Furthermore, user's experiences are cyclic because Smart PSSs offer users the unique possibility to renew their value propositions over time, by means of new elements in the system, features, and content. However, every time the system changes, and users implement changes in their value propositions, they enter an orientation cycle that is influential of their continued engagement with the Smart PSS.

Finally, we identified four main factors that affect the transition from orientation to incorporation in users' experiences with Smart PSSs: 1) *quality of information*, 2) *number of options in the system*, 3) *coherence of functionality*, and 4) *product attributes*. Several features in the Smart PSSs can influence these factors. For example, accuracy of data, and the format in which information is presented, are different features that can influence the quality of information in the system. Furthermore, identified factors and features have been associated with different steps in the temporality of users' experiences with Smart PSSs. For example, quality of information is relevant while unpacking the Smart PSSs but also in later experiences, when exploring the options/elements added to the system. Table 5.3 (page 149) presents an overview of the factors and associated features. Overall, this information is relevant because it can help designers to manage and optimize the experience of users, and trigger positive responses, at specific stages of the user experience.

6.2 Theoretical contribution

As stated, the main contribution of this thesis lies in the broadened understanding of Smart PSS design. We have purposefully followed a multidisciplinary research approach. This approach allowed us to understand the implications of Smart PSS design in relation to the definition of value propositions and their development (i.e., design process), but also in relation to consumers' reactions and evaluations towards these offerings. Furthermore, due to such a multidisciplinary approach, we have built on theory from different fields, such as (traditional) PSSs, design management, operations management, service design and service marketing. Based on our review of this literature, we identified several theoretical gaps and research questions, which together highlight our scientific contribution. These contributions are now discussed in the following paragraphs in relation to each empirical chapter.

First, our review of the literature highlighted the shortage of available information that could aid designers in the definition of Smart PSS value propositions. Past research had discussed the advantages for consumers in the adoption of discrete smart products and e-services (e.g., Meuter et al., 2000; Rijsdijk & Hultink, 2009; Rust & Kannan, 2003). However, more information was necessary, which accounted for the integrative nature of Smart PSSs. Furthermore, the typology of (traditional) PSSs generally acknowledged in the literature (i.e., result-oriented, use-oriented, product-oriented; e.g., Baines et al., 2007; Beuren et al., 2013; Tukker, 2004) was

more focused on business models and transactions. Unquestionably, this information was deemed relevant in the definition of new value propositions. However, it was identified as missing important information for designers, for example, in relation to the user experience and interaction. The characteristics of Smart PSSs discussed in Chapter 3 address this gap in the literature. Particularly, our findings highlight the opportunities for designers to create meaningful interactions, based on the integration of smart products and e-services. Importantly, our findings highlight not only the opportunities for creating meaningful experiences for consumers; they also highlight the opportunities for companies to strengthen their relationships with consumers.

Second, our study of the Smart PSS design process discussed in Chapter 4 was largely based on the literature on operations management and (traditional) PSS design. Authors, such as Baines et al. (2009), Isaksson et al. (2009) and Martinez et al. (2010) have discussed the servitization process of manufacturing organizations. These authors have highlighted the elements of (traditional) PSS design and the challenges product developers face in the integration of service strategies. Moreover, the work of Morelli (Morelli, 2002, 2003, 2006, 2009) played a particularly important role in our understanding of the potential roles/contributions of designers to the design of Smart PSSs. Overall, our review of the literature provided important insights and formed the basis for our study of Smart PSS design: it was concluded that many of the elements, challenges and roles/contributions of designers to (traditional) PSS design would also be relevant for Smart PSS design.

An important limitation of the existing literature, however, is its large focus on (traditional) PSSs that lacked a smart character. We expected the elements of the Smart PSS design, and its challenges, to be influenced by the characteristics of Smart PSSs. This thought was corroborated by our investigation, which pinpointed to distinct elements and challenges of Smart PSS design that are rooted in aspects of the smart product and e-service. Consequently, our theoretical contribution of Chapter 4 lies in the broadened understanding of PSS design. Our research widens the understanding of design processes where the integration of smart products and e-services is core for the development of the value proposition. Particularly, our research contributes to the existing literature by indicating elements and challenges that are distinct of the Smart PSS development context. Regarding the roles/contributions of the designers to Smart PSS design, we can conclude that the theoretical contribution is less apparent albeit relevant. Most of the roles/contributions of designers discussed in Chapter 4 have been discussed in the design and design management literature. However, the exploration of these roles/contributions in a relatively new field (i.e., Smart PSS design) has great practical implications for designers. Such information can help designers better assess their best practices and toolset in relation to Smart PSSs. This and other practical implications of our findings are further discussed in Section 6.3.

Finally, Chapter 5 investigated the effect of design decisions on consumers' experiences and reactions towards Smart PSSs. In this regard, our review of the literature pointed to consumers' understanding of the (Smart) PSS value proposition as an important barrier to their adoption. As discussed by several authors (e.g., Baines et al., 2007; Beuren et al., 2013; Martinez et al., 2010), consumers may require a change in mindset, moving away from the ownership of discrete products, to solutions that oftentimes "ownerless", composed of both products and services, and that encourage a prolonged relationship with providers.

Despite the evident need to understand (Smart) PSSs from a consumer perspective, studies on consumers' evaluations of Smart (and traditional) PSSs are scarce (Mont & Plepys, 2007; Rexfelt & Hiort af Ornäs, 2009). Consequently, our findings in Chapter 5 contribute to the existing theory by providing more information to better understand the aspects that influence the experiences and evaluations of consumers with Smart PSSs. In particular, our study on coherence enlarges the existing understanding of how consumers evaluate integratively the different product and service elements in a Smart PSS. Furthermore, our longitudinal study on consumers' experiences provides an extended view on how consumers experience different product and service elements in the Smart PSS, and how they derive *value-in-use* from the system over time. Overall, Chapter 5 contributes to the existing literature by providing information, based on aspects of the experience and interaction of the user with the system, which can help designers define value propositions that are meaningful to consumers.

Moreover, two particular scholars were of relevance to our longitudinal study on consumers' experiences with Smart PSSs. First, Secomandi's longitudinal study on consumers' experiences with a Smart PSS (2012; Section 2.3.3 and Section 5.2.1) served as inspiration to our research set-up. Our research contributes to his work by exploring the experiences of consumers with a wider set of Smart PSSs, and for various use contexts. Second, Karapano's model for the temporality of user experiences (2013) provided a theoretical ground for our study of users' experiences with Smart PSSs. His work was particularly relevant in understanding the phases consumers go through in their experiences with products. Thus, our findings contribute to Karapano's work (2013) by studying market offerings where smart products and e-service are a fundamental aspect of the value proposition. Moreover, our findings contribute to his work by providing more detail in relation to the aspects that affect the transition from the orientation to incorporation phases in the experience of users with Smart PSSs.

6.3 Practical implications for designers

As shortly discussed in Section 6.2, the findings presented in this thesis have several practical implications for designers. In this section, we discuss these implications

in relation to three aspects: 1) the role of designers in the design of Smart PSSs, 2) design guidelines for Smart PSS design, and 3) tools for Smart PSS design.

6.3.1 The roles/contributions of designers in Smart PSS design

An important conclusion of Chapter 4 was the adequacy of current design skills for the design of Smart PSSs. Our findings suggested various roles of designers, contributing to tackle design challenges, which have been previously discussed in the design management literature (see e.g., Morelli, 2003, 2006; Mozota, 2002; Sanders & Stappers, 2008; Valencia et al., 2013). Consequently, designers possess the skillset required to undertake the Smart PSS design process. Importantly, designers ought to become aware of the elements of Smart PSS design and its district challenges, to be better prepared for this relatively new development context.

In line with the two perspectives followed in this thesis, the findings presented in this thesis point to two district areas where designers' roles gain relevance: the efficacy of the design process, and the creation of meaningful value propositions (cf., Valencia et al., 2013).

In relation to the efficacy of the design process, the large number of stakeholders and the ever-growing, ever-evolving nature of Smart PSSs can complicate the communication and shared understanding of the value proposition among members of the development network. Overall, designers' roles in this area center on facilitating the clear communication of design goal among stakeholders, in integrating the different and possibly conflicting ideas (including those of consumers), also as the system evolve. In relation to the creation of meaningful experiences, designers' roles contribute to better shaping the interaction of the user with the Smart PSS. Designers' understanding of the user and his/her context aids them in the definition of features of the smart product, the e-service, and their integration. Designers facilitate users' understanding of the system, and contribute to the creation of Smart PSSs that are valued over time.

In the following section, we present several guidelines to assist designers in their contributions to the above discussed areas. These guidelines present practical Do's and Don'ts that are based on the overall findings of this research project.

6.3.2 Design guidelines for Smart PSS design

The previous sections provided an overview of our research findings. In this section, we look at these insights retrospectively, looking for connections and interrelations between them. Together, these interconnections between research insights form the foundation of design guidelines to be used by design professionals and students alike, in the design and implementation of Smart PSSs (Table 6.1).

Table 6.2 Overview of guidelines for Smart PSS design

#1: Create awareness among stakeholders of the distinct elements of Smart PSS design
#2: Envision the interplay between product and service elements during the design process.
#3: Make value propositions and their dynamism tangible during the design process.
#4: Make sure your consumers' core needs are met (in a meaningful way)
#5: Implement visible channels to connect providers and users.
#6: Guide users through the installation of the Smart PSS.
#7: Guide users through the different touchpoints/elements in the Smart PSS.
#8: Prioritize both product and e-services equally when designing the user experience.
#9: Help users navigate through options meant to renew the value proposition.

#1: Create awareness among stakeholders of the elements of Smart PSS design

Help the members of the development network to understand the uniqueness of Smart PSSs. The design of Smart PSSs is a relatively new activity. Consequently, its characterizing elements could be unknown to stakeholders. The understanding of the elements Smart PSS design is important because they are the root cause of the challenges of Smart PSS design. Thus, by creating such awareness, designers and other stakeholders can be better adept to tackle the Smart PSS design process effectively. Awareness should take place in the early stages of Smart PSS design, when early concepts and opportunities are discussed. Overall, creating awareness on Smart PSS design contributes to the efficacy of the design process because it helps to create a shared understanding among stakeholders of the opportunities of Smart PSS design, and of the aspects to be considered in the design process.

To create awareness on the elements of Smart PSS design, designers can play a role in facilitating discussions, for example, by asking key questions that bring the attention to overlooked aspects of the value proposition. Moreover, designers can contribute by developing new design tools and methods that take into account the elements of Smart PSS design. In this regard, Section 6.3.3 (discussed later in this chapter) highlights the potential of our research findings for the development of new tools for Smart PSS design. Section 6.3.3 provides a vision on how the characteristics of Smart PSSs (discussed in Chapter 3) could potentially be used in co-creation sessions, contributing to the awareness creation of the opportunities for companies and consumers of developing such offerings.

#2: Envision the interplay between product and service elements during the design process

Smart PSSs integrate smart products and e-services into single solutions, and such integration prompts the interplay between product and service elements in the delivery of value propositions. Accordingly, product and service characteristics should be forethought and made complementary to strengthen the value proposition of individual elements and the system as a whole. Failure to create this complementarity/synergy can result in incoherencies within the system that are detrimental for users' experiences. This thesis discussed four types of coherence, which designers should consider while envisioning the interplay between product and service elements of Smart PSSs: *visual coherence*, *coherence of symbolic meaning*, *coherence of functionality*, and *coherence of interaction*.

First, *visual coherence* is the cohesiveness between the visual representations surrounding the Smart PSS, such as colors, shapes, images, or written language. This type of coherence can help consumers associate different elements/touchpoints as belonging to the same Smart PSS. Second, *coherence of symbolic meaning* relates to the fit between different elements in the Smart PSS, in relation to the affective or cognitive associations (e.g., simple, professional, classy) that users attach to them. Coherence in symbolic meaning can have positive effects on brand evaluations (van Rompay et al., 2010). Moreover, our research demonstrated that consumers value the coherence in symbolic meaning between different elements in the Smart PSS. Thus, designers can strategically define the attributes of the brand that they want to convey and integrate them in the different elements of the Smart PSS (Karjalainen & Snelders, 2010), aiming for coherence between them to reinforce the story around the Smart PSS.

Third, *coherence of functionality* is defined as the well functioning of the Smart PSS, in the interaction between its different touchpoints. In this regards, it is important to care for the accurate and flawless transfer of information between touchpoints (e.g., from e-service to product and vice versa). Moreover, when giving the option to integrate with other devices, designers ought to assure that the integration works seamlessly and does not disrupt the experience with the Smart PSS negatively. Inaccurate information and issues with data transfer can negatively impact the trust in the system. Furthermore, coherence of functionality is important because it can influence how well users understand and interact with the system, in other words, its ease of use. This relates to the final type of coherence discussed in this thesis, *coherence of interaction*, defined as the consistency across touchpoints in the interaction with the users over time. Designers ought to care for the consistency in the user interaction as the system evolves, to minimize the orientation efforts when new features and products are introduced that lead to negative experiences.

#3: Make value propositions and their dynamism tangible during the design process

In line with past research (e.g., Morelli, 2009; Secomandi, 2012), designers can use their toolset, such as prototypes, storyboards, scenarios, and drawings, to visualize the value proposition and make value propositions more tangible. Making value propositions tangible is important because it can reduce the complexity of the design process, caused by the multi-touchpoint nature of Smart PSSs and the broadened design options. Making value propositions tangible can have important implications for the communication during the Smart PSS design process, and consequently, its outcome. A tangible value proposition can aid the communication among the large number of stakeholders that take part in Smart PSS design. Furthermore, it can tackle the important challenge of creating a shared understanding of the value proposition, how this value is delivered, and increase the overall coherence of the system. A tangible value proposition can help envision the interplay between product and service elements in the system (guideline #2), and contribute to the awareness of key aspects in the system, and their implications for the design process (guideline #1).

#4: Make sure your consumers' core needs are met (in a meaningful way)

Invest resources to understand the core needs of consumers towards the Smart PSS. Options in terms of content provide advantages to satisfy the individual needs of consumers in various ways over time. However, it is important to understand the underlying need or the core value that the Smart PSS offers to consumers, and to guarantee that this need is fulfilled in a satisfactory way as the system evolves. For example, if the goal of the Smart PSS is to measure the user's activity, the measurement mechanism should be accurate enough to create trust among users. Yet, the data measured ought to be presented in a meaningful way promoting the easy interpretation of information by consumers. This core need, the easy interpretation of reliable data, should be maintained throughout time, as new elements (e.g., new smart products, e-services) or options (e.g., ways of presenting the information) are introduced.

Furthermore, achieving a clear focus on the core needs of consumers can have relevant positive effects for the efficacy of the design process. Our findings suggest that the broadened design alternatives available during Smart PSSs can be an overwhelming factor to designers (Section 4.2). Thus, when translated into requirements, consumers' needs serve as a tool in the assessment of alternative value propositions as the system evolves, and the selection of solutions with increased value to consumers over time. To this end, co-creation activities involving potential consumers can lead to the identification of relevant characteristics for the Smart PSS solution (Morelli, 2009; Rexfelt & Hiort af Ornäs, 2009). Consumer research tools, such as focus groups and observations, can also lead to the definition of a functional baseline for the introduction of the Smart PSS.

#5: Implement visible channels to connect providers and users

Discussions with participants in our user studies taught us that Smart PSSs are perceived to be innovative solutions, which are not expected to be complete or flawless when they reach the market. Users demonstrated a generally positive disposition towards Smart PSSs that maintained an open communication, updating users about limitations or errors in the system. Participants were patient concerning the flaws of the Smart PSSs when they were aware that providers worked on a solution. Thus, companies should aim at implementing clear and visible channels to inform users about the introduction of new options, touchpoints and other changes in the system over time. Such communication is important because it can motivate those who are no longer engaged with the system to re-explore the value proposition and re-integrate the Smart PSS in their lives.

Furthermore, we noticed the trend of having primary and secondary e-services implemented in the Smart PSS. For example, a primary e-service could be considered an app where consumers have direct access to the data collected through the smart product. Such a touchpoint is primary to users because it is likely to be accessed periodically, and primary to the value creation process with the Smart PSS. In contrast, web portals and other communication channels, such as Twitter, could be considered secondary; especially when not accessed periodically by users. Users generally accept the diverse purposes of different touchpoints. However, some choose to disregard secondary touchpoints and miss out on potentially relevant information regarding the system. Thus, our recommendation is to use primary e-services when implementing communication channels, to assure that relevant information reaches a broad range of users (e.g., those without affinity for social media) promptly.

#6: Guide users through the installation of the Smart PSS

Designers should pay particular attention to the installation of the Smart PSS. Our research points to this step as an important gate to shape the attitudes of consumers towards Smart PSSs; whether they are perceived as serious solutions or unconvincing gadgets. While this guideline may seem logical, our research has shown that users do struggle in this step. Particularly, users who are less experienced with similar technologies struggle to install the Smart PSS effectively.

Users typically miss relevant information to support the installation of the system. When the installation is unsuccessful, the Smart PSS may not work as envisioned, or may fail to deliver the intended value proposition. Thus, facilitating a trouble-free installation is undoubtedly a real challenge to providing meaningful experiences across a wide range of users. To counter these issues, designers need to design Smart PSSs that guide users thoughtfully through the installation and set-up processes. If an instructions manual is not included, clearly provide a short overview of the steps to be followed during the installation process and where to find further

information on the installation. If a plug and play experience is chosen, make sure the design of the product is intuitive enough so that users are able to operate the device in the early stages (e.g., how to switch the device on and/or navigate through the interface), to get the installation started.

#7: Guide users through the different touchpoints/elements in the Smart PSS

As discussed, user experiences with Smart PSSs are complex. An important element contributing to this complexity is the multiplicity of elements (or touchpoints), which together form the value proposition. When the Smart PSS does not create awareness of these different elements (i.e., smart products, e-services), consumers do not achieve a view of the overall system, and their attention is diverted to the different single elements that compose it. Thus, a challenge for designers is to create awareness of these different elements and how, they together deliver value. As previously discussed, caring for coherence while designing the proposition helps unify individual elements in the system. However, without awareness of these elements, users do not attain a full picture of the system, potentially lacking on important value propositions.

Thus, designers need to aim at presenting an overview of the system to consumers by mapping the different touchpoints/elements in the system and how they come together to create value. If different touchpoints bring different kinds of value, emphasize their differences so that users recognize the instances and goals for which they deliver value. If several smart products are available in the same system (a.k.a. ecosystem or system of systems, Porter & Heppelmann, 2014), and integrated through the e-service, facilitate the understanding of their particular contributions to the value proposition. Importantly, the orientation of consumers in relation to different touchpoints/elements in the Smart PSSs must take place from an early stage. As demonstrated in this thesis, relevant questions regarding the functionality and value proposition can arise as early as the unpacking of the Smart PSSs takes place. Failure to orient users successfully already from this point on can stop them from exploring all the possibilities of the system further.

#8: Prioritize physical product and e-services equally when designing the user experience

This thesis has largely discussed the features of the e-service that play a role in Smart PSS design. However, users evaluate Smart PSSs integratively. They regard the characteristics of both e-services and smart products to assess the overall value delivered by the solution. Thus, we want to emphasize the relevant role of the smart product in the formation of positive experiences. Digital platforms are important because they often mediate the delivery of content or information to users. Nevertheless, users are aware of products (wearable and others), and the aspects

of them that influence their experiences with the Smart PSS. Smart products are an important means to deliver the service, and an agent to enhance/reduce the value consumers attach to the system. When aspects of the smart product (e.g., material, weight, sounds) do not meet consumers' expectations, they become detrimental to the user experience and undermine overall value of the Smart PSSs.

#9: Help users navigate through options meant to individualize the value proposition

Options to individualize the value proposition (e.g., content, information, data) can lead to positive experiences. However, when not managed properly, options are overwhelming to consumers, they complicate the understanding of the value proposition and have a detrimental effect on the experience of users with the system.

Consequently, it is of great relevance to help users navigate through the options offered by the system. In doing so, designers must take into account the varying needs of potentially different users, the modularity of the Smart PSS (Morelli, 2011, 2015), and the possible changes the Smart PSS undergoes over time. Designers must be particularly cautious in facilitating the effective navigation of Smart PSSs, which offer varying options (e.g., different smart products, different content) to satisfy the needs of different users. When searching for new options, the Smart PSSs must turn the sorting of irrelevant options (e.g., options that do not meet their individual needs, or which are not enabled by the technical proficiency of the smart products they own) into an easy and efficient process. By doing so, designers can contribute to the formation of a positive mindset in the exploration and further engagement with the system.

6.3.3 Tools for Smart PSS design

The previous section presented the design guidelines for Smart PSS design. In the present section, we provide a discussion on design tools that can facilitate the design of Smart PSSs. In particular, we provide a view on how the characteristics of Smart PSSs (Chapter 3) can be used as a tool to aid the design process of Smart PSSs.

As previously discussed, traditional tools used in product and service design, such as prototypes, storyboards, and other visualizations, can aid in the definition of new Smart PSS value propositions. Next to these, there are other existing tools that designers can use to facilitate the understanding of the value proposition among stakeholders during the design process. Morelli (2006), for example, discusses different tools for PSS design, such as interaction maps, use cases, and service blue prints, which can also be used in the Smart PSS design context. As described by Morelli, these tools can aid in the identification of relevant actors, variations of the PSS configuration according to different scenarios/context, and the graphical representation of PSS solutions respectively.

Beuren et al (2013, p.227) also list several methodologies and tools for PSS design. From these, we can particularly recommend MePSS (van Halen et al., n.d.). The tools/methodologies in this source are aimed at the development of traditional PSSs with an environmental impact. However, both traditional and Smart PSSs are known to have multiple touchpoints and a large number of stakeholders involved. Consequently, tools particularly aimed at mapping the system, identifying stakeholders, their roles and contributions in the delivery of value, can be of value in the early stages of the Smart PSS design process. Overall, the combined use of various tools, with an emphasis on visual aids and tangibility, can reduce the abstractness of Smart PSSs and aid in the definition of meaningful and coherent value propositions.

Exploring the development of a Smart PSS design tools based on our research insights

One of the conclusions we arrived to in Chapter 4 is that, despite the usefulness of traditional product and service design tools, important limitations remain in their efficacy for Smart PSS design. In particular, such tools do not appear to sufficiently address two significant Smart PSS design challenges: the definition of the value proposition, and the effective communication among stakeholders (in relation to the system that is ever-changing).

Keeping these issues in mind, we attempted to translate the results of Chapter 3 into a practical tool for the design of Smart PSSs, which could address the above limitations (we describe the format of the tool in the subsequent section. A graphical representation can also be found in page 214 and Appendix H). The relevance of the tool is that it takes into account the smartness of products as well as the digital nature of the service, making it particularly suited for discussions around Smart PSS value propositions. Furthermore, the tool facilitates the discussions among stakeholders in the early phases of the design process. Particularly, the tool can contribute to the efficacy of the design process, in relation the first four guidelines of Smart PSS presented in Section 6.3.2:

First, the tool can contribute to create awareness of the opportunities facilitated by the integration of smart products and e-services. As the tool is based in the characteristics of Smart PSSs, it highlights the opportunities for consumers and companies of adopting these kinds of solutions. Through the use of the tool, participants in a co-creation session can attain an overview of the characteristics, and examples of features that facilitate their implementation, thus enhancing the awareness of the options offered by such system (more on the format of the tool is discussed in the following section).

Second, the tool can contribute to envision the interplay between product and service elements during the design process. The tool is a graphical representation of the characteristics of Smart PSSs. In combination with other tools, such as storyboards and customer journeys, the tool can help envision the aspects of the

smart product and the e-service that are key to the user experience; and how they come together to deliver value propositions.

Third, because of its graphical format, the tool can contribute to make the value propositions more tangible during co-creation discussions, as well as their expected evolution over time. For example, the tool can help depict graphically the present value proposition and discuss it against a foreseen future one. Consequently, in combination with tools, such as system maps (van Halen et al., n.d.), the tool could help to envision the necessary adjustments to the system, for instance, to identify the involvement of new relevant stakeholders, needed to support the implementation of new elements/features in the system.

And fourth, the tool could facilitate the evaluation of value propositions against the core needs of consumers. Particularly, the tool could aid in maintaining focus on the core needs that should be addressed by value propositions. The graphical representations that come with the tool can thus be used as reference points when new ideas are brought to the table, to support their evaluation and section process.

Format

The preliminary format of the tool was developed in collaboration with industry partners involved in the set-up of the researcher (Section 1.4). In this format, the tool is composed of three main elements: 1) an overview of the characteristics of Smart PSSs, 2) a 'reflection sheet'; a form to fill-in a description of each characteristics, in terms of features (e.g., 'providing feedback on collected data by means of informative graphs'), in relation to the new Smart PSS value proposition, and 3) a 'wheel of characteristics' (shortly discussed in Chapter 5), meant to represent the characteristics of the newly defined Smart PSS graphically.

The overview of the characteristics was achieved by developing boards of A3 size that should be visible to all participants. In total, eight boards were developed; one for each of the characteristics discussed in this thesis. Figure 6.1 shows an example of such board for the characteristic 'consumer empowerment' (remaining boards can be found in Appendix H). Furthermore, one open (i.e., blank) form was developed for new possible undefined characteristics emerging during co-creation sessions. This open format was deemed necessary due to the newness of the Smart PSS concept, and the potential identification of new relevant characteristics.

As seen, the board has four elements. First, each board displays the name of the characteristic as defined in this thesis. Second, the board outlines the key aspects defining each characteristic. For example, for consumer empowerment a key aspect is 'generating knowledge'. Third, the board lists one or several key questions, meant to trigger discussions among participants in relation to the new Smart PSS value proposition. For example, for 'consumer empowerment' the underlying question reads: *How important is it to expand the control of end-users,*

helping them make decisions, and take action in their own terms? Whereas for the characteristic 'community feeling', which focuses on how the Smart PSS facilitates the communication between consumers, the questions read (Appendix H): *How important for the use-context is it to facilitate the communication between end-users? How important is it for such communication to be mediated by the system?* Fourth, each board displays examples of features/ways of how each characteristic is embodied. For the present format, it was decided to use examples of commercially available Smart PSSs that could be more relatable to participants (thereby increasing the tangibility of the value proposition, i.e., guideline #3).

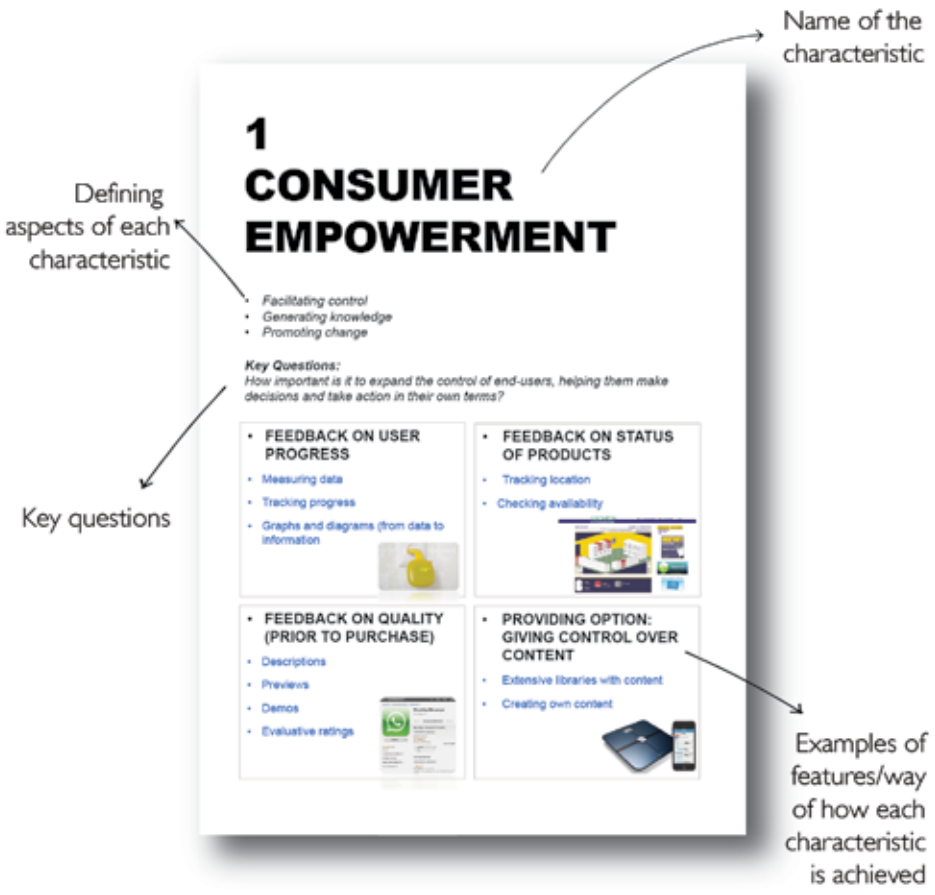

Figure 6.1 Example of overview board for the characteristic 'consumer empowerment'

While the above-described boards were developed to trigger discussions among

stakeholders, we deemed it important to document relevant ideas in relation to the new value proposition and to increase their tangibility. Consequently, the 'reflection sheet' was developed (also in size A3), which could serve as a canvas to list ideas emerging from the underlying questions outlined for each characteristic (Appendix H-2). For example, in relation to 'community feeling' it could be decided that *'the Smart PSS should facilitate the communication of users via third party services, such as Facebook and Twitter'*. In our project, the tool was tested through short co-creation sessions (i.e., between one and two hours) with professionals with different backgrounds, with potentially no visualization skills. Consequently, it was decided to document value proposition ideas in written format in order to facilitate the process. However, the reflection 'reflection sheet' could be used with other traditional design tools, such as storyboards and prototypes, to further increasing the tangibility of design ideas.

Furthermore, the 'reflection sheet' is meant to clearly state the value proposition to the Smart PSS. This value proposition, we recommend, should be stated in terms of the objective of the Smart PSS in relation to the user. For example, an objective could read as: *'To facilitate the easy measuring of blood pressure by heart patients, and the fast communication between heart patients and medical experts'.* The purpose of such objective is to identify the user for which the Smart PSS value proposition is developed, as well as where the strengths of the value proposition should lie. In the example above, the end-users are heart patients. Whereas the characteristics that are core to the value proposition are potentially two: 'consumer empowerment' and 'individualization of services'. If two value propositions are created for the same Smart PSS, but for different users, we advise to craft distinct names for each configuration, which evidences their distinct values.

Finally, the relevance of each Smart PSS characteristic is expected to vary according to the context, the user for which the solution PSS is developed, and over time. Accordingly, a 'wheel or characteristics' was developed to provide a graphical overview of the characteristics most relevant to a particular value proposition. Furthermore, the wheel was developed in the purpose of enticing relevant conversations regarding the strength of different characteristics, and to facilitate the easy comparison between varying value propositions. Figure 6.2 shows an example of a wheel for Nike+, resulting from a session with industry partners to analyze existing cases of Smart PSSs. Note that for this particular example the characteristic 'community feeling' ranks particularly high, while 'service involvement' is relatively low. The reason for this is that the value proposition of Nike+ is based on the idea that users can support each other in achieving their individual goals in relation towards their physical condition. Conversely, the service involvement is believed to be low, as there is limited direct communication between Nike and individual users. Rather, Nike+ was reasoned by participants to be used as a platform to promote the Nike brand and its products. Moreover, there is a blank space in the wheel, just as with

the boards of characteristics, to stress the possibility of adding new characteristics identified/defined during the co-creation sessions.

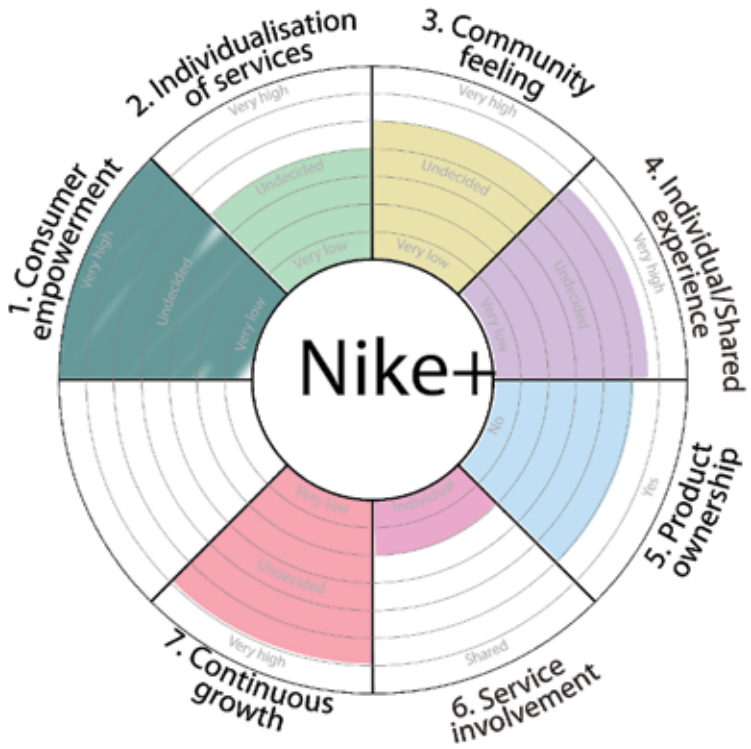

Figure 6.2 Wheel of characteristics

Experienced relevance of the characteristics of Smart PSSs as a tool

The tool was tested in several informal meetings with generally positive results. In our project, for example, the characteristics were used to discuss existing Smart PSSs and to attain a better understanding of the core strength in the value proposition of several solutions (as in the example of Nike+ described above). In another instance, the characteristics were used to discuss design projects and to identify design opportunities. Think for example of a Smart PSS with different types of users involved. Are the needs of all users the same? Do all characteristics have the same value for all types of users? The tool can be used to discuss these types of questions, and to define variations of the Smart PSS according to different users or contexts. Furthermore, the outcome of the tool can be used as input for further design, for example, when discussing the implementation of the Smart PSS (e.g., business model), or designing the individual elements in the Smart PSS (e.g., do the features implemented in the e-service fulfill the value proposition?).

Overall, we experienced the characteristics of Smart PSSs as aiding co-creation discussions and leading to interesting questions on the value they bring to different stakeholders. As previously discussed, we experienced the characteristics as contributing to the tangibility of the value proposition. The format of the tool provided a visual representation of the aspects that characterized value propositions. These visual representations facilitated the understanding–at a glance–of the key attributes that the new Smart PSS value propositions should encompass, making it easier for participants of co-creation sessions to discuss ideas at an abstract yet tangible level. Importantly, the present format provides flexibility to the varying needs of projects and stakeholders. The illustrative examples used in each board of characteristics can be customized according to the specifics of the Smart PSS under discussion (e.g., by using examples of features used by competing Smart PSSs in a specific design context).

6.4 Practical implications for the design of traditional PSSs

Section 6.3 discussed the practical implications of our findings for design of Smart PSSs. In this section, practical implications for the design of traditional PSSs are discussed.

Our conceptualization of Smart PSSs demarcated an important difference between smart solutions and traditional PSSs. In particular, our definition points at the smart character of the product and the 'autonomous' interaction of users with the system through the e-service. Such conceptualization is particularly true for consumer solutions, such as those employed as stimuli in this thesis. However, it is important to acknowledge the increasing role that smart technologies play in the implementation of solutions discussed in the traditional PSS literature. Take for example the remote monitoring of machines in the business-to-business arena. For instance, Xerox®Remote Print Services (https://www.xerox.com) connects office and productions printers to a Xerox's server, enabling the automatic transmission of relevant information to service employees, who can diagnose and resolve problems remotely. In addition, clients gain access to personalized dashboards that provide an overview of printers' metrics, and facilitate the automatic solicitation of replacement supplies. Other companies implementing similar tools to support their services include Philips (http://www.usa.philips.com/healthcare) with its healthcare devices, and Volvo with its connected trucks (http://www.volvotrucks.com/trucks). Also, similar examples can be found of PSSs with a social or environmental impact, and which have a 'smart' character. For example, Morelli (2015) discusses the development of online platforms to facilitate the (face-to-face) interaction between members of a community, the provision of services, and to promote the development of the community as a whole.

Thus, the development of technologies has narrowed the gap between traditional

PSSs and Smart PSSs. As such, the insights and guidelines contained in this thesis are also of relevance to designers and companies of traditional PSSs, willing to transition to Smart PSSs, by implementing smart products and e-services as part of their solutions. Furthermore, the business models of traditional PSSs (i.e., typology; product-oriented, use-oriented, result-oriented, discussed in Chapter 2, Section 2.1.2) provide a good basis for the design and implementation of Smart PSSs (B2B and B2C). For example, through a clear outline of the business model, designers can better understand the different roles of users and providers within the system, and their expected interactions, to create platforms (i.e., smart products and e-services) that support/enhance their interrelation through the Smart PSS. However, some researchers have expressed concerns for the lack of detailed descriptions in the traditional PSS typology that facilitate the effective implementation of PSS strategies (Beuren et al., 2013; Mont, Dalhammar, & Jacobsson, 2006; Reim et al., 2015). Reim et al. (2015), for instance, conducted a review of the existing literature and concluded that a deeper understanding at the tactic level (decisions made around business models) is necessary to develop more accurate value propositions for stakeholders. Aiming to address this knowledge gap, the authors discuss different identified tactics in relation to product and service design, marketing, development network and suitability. Marketing tactics, for example, relate to how companies can take advantage of the increased interaction with customers to collect relevant market and consumer insight. This insight, in turn, can be used for the design of products and services that meet the needs of customers, for example, by customizing services or designing products that facilitate serviceability (i.e., maintenance, easy diagnostics, etc.).

While this thesis does not focus on the development of business models, the questions addressed through the research can be influential for the implementation of (Smart) PSS strategies. Chapter 3, particularly, discusses aspects of Smart PSSs that can be manipulated to create more meaningful interactions between providers and consumers. Furthermore, Chapter 4 discusses how designers contribute to tackle design challenges and use their skillset to influence the design process and the development of value propositions. Finally, Chapter 5 discusses the process of value creation and attitudes of users towards PSSs. These user experience insights can, in turn, be used in the design of value propositions embodied in PSS solutions. Accordingly, our findings provide further insight into the implementation of tactics, particularly at the product and service design levels, with potential impact on PSS business strategies.

6.5 Opportunities for future research

The multidisciplinary approach followed in this thesis has granted us numerous advantages to our study of Smart PSS design. The several qualitative studies we conducted allowed us to dive deep into the motivations of both consumers and

designers. Furthermore, the quantitative study reported in Chapter 5 provided us with a first understanding of the impact coherence has on consumers' evaluations towards Smart PSSs. There are however several limitations to our research approaches, outlined through our different empirical studies, which bring about opportunities for further research. The aim of this section is to highlight these several research opportunities, regarding topics and research questions that require further study.

First, an aspect that has gained relevance throughout the course of this research is the increasing capability of Smart PSSs to connect, communicate and cooperate with others smart products, e-services and Smart PSSs. These groups of systems have been called ecosystems or systems of systems (Porter & Heppelmann, 2014). In an ecosystem, several groups of Smart PSSs can be developed by the same provider, or be supported by several providers who work collaboratively, opening their platforms to diverse developers. For example, Withings (www.withings.com) has created an ecosystem of Smart PSSs, all directed towards personal health care. In their ecosystem, several smart products, such as a weight scale, blood pressure monitor, activity tracker and sleep tracker, measure distinct indicators of users' health, providing an overall view of their physical condition. These smart products are integrated through an e-service that provides a comprehensive overview of data collected through the smart products, presenting an overview of information that can help users to set health-oriented goals. Another example relates to the smart home. In such an ecosystem, various Smart PSSs developed by different providers, such as kitchen appliances, security systems, sound systems, etc., collaborate with one another, and are integrated through e-services.

Ecosystems are a topic of relevance for Smart PSS design because we foresee forthcoming value propositions to be developed on the basis of this premise. Overall, our research has touched upon some of the aspects that contribute to the formation of positive experiences in the integration of Smart PSSs with other systems. The examples used in this thesis are both individual Smart PSSs and Smart PSSs belonging to an ecosystem. However, the interplay between such systems was not the focal point in our investigation. Thus, further research is needed to better understand the contexts where open or close systems are favored. Moreover, more research is necessary to understand factors that influence the formation of positive experiences during the interplay between various Smart PSSs. Among the topics of interest for further research are the impact of coherence within the ecosystem on consumers' perceptions and experience, and the challenges for companies of developing open systems. For example, the effects on trust of opening a platform to a third party ought to be better understood. Such effect should be studied by means of quantitative and qualitative consumer studies, to better manage the user experience in those upcoming contexts.

Second, as described in the preceding section, the pass of time and the

development of technologies have narrowed the gap between traditional PSS and Smart PSSs. This means that the findings presented in this thesis are to an extent transferable and of relevance for traditional PSS design. However, it also means that aspects such as sustainability, and the various business models discussed in the traditional PSS literature (i.e., solution-oriented, use-oriented, product-oriented), gain relevance in the Smart PSS field. These topics have been tangentially discussed in this research. Consequently, more research is needed, which can deepen the connection between both research fields; and which can highlight the ways in which traditional PSSs and Smart PSSs design can build on one-another. Relevant questions are, for example: Can Smart PSS value propositions work in favor of the adoption of ownerless solutions? How are solution-oriented and use-oriented business models experienced by consumers over time? What are the facets of these models that contribute to the formation of positive experiences in the consumer market?

Third, our findings are largely based on qualitative data. As discussed, this data provided us with rich contextual information, which forms the foundation of our findings. However, future research could set out to explore Smart PSS design using different research approaches. Of particular interest are studies of companies developing Smart PSSs, both in servitizing and productizing contexts. Case studies, for example, could help deepen the understanding of the Smart PSS design process for specific contexts. Furthermore, through quantitative studies, a larger set of professionals with different backgrounds could be reached, which can provide a more complete view on the elements and challenges of Smart PSS design, and the roles/contributions of designers to such design process.

Fourth, the research perspectives studied in this project look at the individual elements that encompass the Smart PSS. Given the important role that designers play in the definition of new value propositions, our aim was to provide designers with information that could guide them in the definition of Smart PSSs; to provide them with a better understanding of the aspects that can influence users' interactions and experiences. Our approach allowed us to attain a detailed view on the features that can trigger positive and negative reactions on consumers, both for smart products and e-services, and to arrive to practical do's and don't for their design and implementation. Another important aspect we aimed to address is the integration of such individual elements–and their features–in a coherent overall value proposition. Our goal was to create awareness of how different types of coherence can trigger positive/negative responses among consumers, and the challenges for designers of achieving such coherences (see e.g., Section 6.3.2). However, because our focus on the different product and service elements composing the system, the interrelation of such elements in the value creation process may not have been sufficiently addressed (e.g., how different elements in the system are bound together through the system, and the business process/services that facilitate the delivery of the value proposition to consumers). A way to address this interrelation is to further the

study of consumer's experiences/evaluations of Smart PSSs through the lens of the Service-Dominant Logic (i.e., S-D Logic; Vargo & Lusch, 2004, 2008). Under the S-D Logic, products are seen as distribution mechanisms for the provision of services. Under this paradigm, the service (i.e., the overall value proposition, including smart products, e-services, infrastructures, etc.) becomes the fundamental basis for exchange, which reduces the focus on individual elements, and highlights the role that the aggregated solution plays in the value co-creation process with consumers. Following the S-D Logic perspective in future research could thus lead to additional/complementary insights to the findings presented in this manuscript.

Finally, further research should set out to study the effectiveness of traditional product and service design tools in the design of Smart PSSs. Our research highlighted several advantages and disadvantages of the existing toolset for the design of Smart PSSs. However, further research is necessary to measure the impact and effectiveness of such tools in tackling specific design challenges. Such information is necessary because it can direct designers more efficiently to specific issues to be addressed in the development of new tools and methods for Smart PSS design. Moreover, the tool presented in this chapter (based on the characteristics of Smart PSSs) portrays the potential of our research insights for the development of new Smart PSS designs. The evaluation of the tool, however, had a pragmatic nature. While positive results were obtained from our various testing sessions, the effectiveness of the tool needs to be more rigorously tested, assessing its value for Smart PSS design, of preference with ongoing design projects.

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Appendices

Appendix A: List of selected stimuli for Study #1-a

#	Product-service system (in alphabetical order)	Source
1	Albert Hein Self-Scanning	http://ahxlelandstraat.nl/zelfscan.html
2	AR.Drone and iPhone	http://ardrone.parrot.com
3	Avelle (also known as Bag Borrow or Steal)	http://www.bagborroworsteal.com
4	Blood Pressure Monitor	http://www.withings.com
5	Book Crossing	http://www.bookcrossing.com
6	iMarker and Color Studio HD App	http://www.griffintechnology.com/crayola-colorstudiohd
7	DirectLife	http://www.directlife.philips.com
8	DE CoffeeVending Machines (office)	https://www.jacobsdouweegbertsprofessional.nl/koffiemachines/
9	Fiat eco:Drive	http://ecodrive.driveuconnect.eu/portal/en/Content.aspx
10	Hema Photobooks	http://foto.hema.nl
11	Green wheels	https://www.greenwheels.com
12	Interactive TV Ziggo	https://www.ziggo.nl
13	Smartphones and apps (e.g., iPhone)	http://www.apple.com

(Continued...)

(...Continued)

#	Product-service system (in alphabetical order)	Source
14	Kindle	https://kindle.amazon.com
15	Laundry View	http://www.laundryview.com
16	Liftmaster® 8550 and Internet Gateway	http://www.liftmaster.com/lmcv2/products/introducingliftmasterinternetgateway.htm
17	Multi-laundry room	
18	Nike+	http://nikerunning.nike.com
19	Octopus Beats Watch	http://www.beats.com.hk
20	Philips Lifeline	http://www.lifelinesys.com/content/lifeline-products/auto-alert
21	Poken	http://www.poken.com
22	PT/INR Self Testing	http://www.inrselftest.com
23	Ray-Ban Virtual Mirror	http://www.ray-ban.com/usa/science/virtual-mirror
24	Sifteo Cubes	https://www.sifteo.com
25	Skinit	http://www.skinit.com
26	The Living Christmas Company	http://www.livingchristmas.com
27	The WiFi Body Scale	http://www.withings.com
28	TomTom	http://www.tomtom.com
29	Wattcher	http://www.wattcher.nl

Appendix B: List of resulting codes, themes and characteristics identified in Studies #1-a and Study #1-b

Code	Theme	Relation to Characteristics
1. Control over own progress 2. Control over shared content: Privacy 3. Controlling own experience 4. Controlling content	Control	Consumer Empowerment
5. Type of Feedback (user/personalized/preview/easy to understand) 6. Accuracy 7. Action-reaction	Feedback	Consumer Empowerment
8. Collecting data 9. Type of content 10. Measuring data	Data	Consumer Empowerment
11. Tracking (development/location/state)	Tracking	Consumer Empowerment
12. Encourage activities 13. Reducing tasks	Goal: Activity oriented	Consumer Empowerment
14. Create a personalized product/experience 15. Self expression 16. Trust 17. Risk (Reduced risk) 18. Empowerment	Goal: Consumer experience	Consumer Empowerment

(Continued...)

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Code	Theme	Relation to Characteristics
19. Digital servicescape (Computer as interface) 20. Identifying (Account) 21. Service= 'They do something for you' 22. Service reaching consumer/real person/push notifications	Service	Individualization of Services
23. Connecting people 24. Easy access to information 25. Level of experience/group/individual 26. Consumers reaching other consumers/exchanging content/sharing 27. Transferring data	Connection	Community Feeling, Individual/Shared Experience
28. General procedures (ordering/payment/delivery) 29. Before/after purchase experience 30. Paying for extended experience 31. Service=dynamic, not static 32. Service=Someone is behind it	Business model	Service Involvement
33. Your own 34. Shared PSS 35. Temporary use	Ownership	Product Ownership
36. Continuous growth 37. Ecosystems 38. Evolution=Not changing entire system 39. Gamification 40. Clear roadmap of offering	Continuous Growth	Continuous Growth

Note: The table lists the 40 most relevant codes related to the characteristics of Smart PSSs. Code 1-35relate to the characteristics of Smart PSSs, as reported in Study #1-a. Codes 36-40 belong to "Continuous Growth", as identified in Study #1-b. Remaining codes have been deliberately excluded from the table. Even though they have helped to develop our theories, they relate to other aspects, such as definitions (e.g., PSS=product and service inseparable) and product requirements (e.g., data storage, portability), which do not directly relate to our research objective.

Appendix C: List of resulting codes, constructs and themes of Study #2

Code	Construct	Theme
1. Different stakeholders at different stages of the design process 2. Development through development network	Large number of stakeholders	(Elements of) Design Process
3. Continuous growth 4. Gamification 5. Evolution is not changing entire system 6. Ecosystems	Ever-growing, ever evolving	(Elements of) Design Process
7. Numerous design possibilities 8. Multi-touchpoint	Multi-touchpoints: Broadened design options	(Elements of) Design Process
9. Context dependent 10. Different goals, different levels of implementation 11. Different goal influence complexity/ characteristics/configuration of Smart PSS	Context dependent	(Elements of) Design Process
12. Challenge: Defining correct value for consumer 13. Challenge: Identifying correct end-user 14. Data vs. Information 15. Challenge: Identifying consumers wants and needs	Defining the value proposition	Challenges
16. Challenge: Fast developing markets 17. Challenge: Fast design processes 18. Challenge: Clear roadmap of offering 19. Challenge: Limitations in technology	Maintaining the value proposition over time	Challenges

(Continued...)

(...Continued)

Code	Construct	Theme
20. The bigger the scale (of Smart PSS) the more multiuser 21. Challenge: Engaging consumer 22. Recurrent interaction through value creation	Creating high-quality interactions	Challenges
23. Coherence: Logical configuration of elements 24. Coherence: One brand 25. Coherence: Reducing complexity for user 26. Coherence: Creating value for users	Creating coherence in the Smart PSS	Challenges
27. Different stakeholders, different perspectives 28. Different stakeholders, different approaches 29. Challenge: Identifying stakeholder capabilities for different stages of design process	Stakeholder management	Challenges
30. Challenge:Visualization of ideas 31. Challenge: Cognitive shifts (from abstract to specific)	The clear communication of design goals	Challenges
32. New type of offering, unknown process 33. Combined development of product and service 34. Use of regular design tools 35. Different tools for different projects	The selection of means and tools in the design process	Challenges

(Continued...)

(...Continued)

Code	Construct	Theme
36. Defining the UX around the Smart PSS 37. Tool_Covering full-customer journey 38. Setting customer-experience goals 39. Assessing consumers' perceived value 40. Tool_Prototyping to get consumer feedback 41. Tool_Talking to end-user	Guardians of user experiences	Roles/ Contributions of designers
42. Thinking of the future_scenario thinking 43. Understanding how end-users will use the system	Foreseers of future scenarios	Roles/ Contributions of designers
44. Designers as facilitators 45. Project champion 46. Development network meetings: Creating shared understanding among stakeholders 47. Stakeholder management by designers 48. Identifying relevant actors/ stakeholders 49. Tool_asking questions	Integrators of stakeholders' needs	Roles/ Contributions of designers
50. Designer as problem solver 51. Putting the system together 52. From concept to solution	Problem solvers	Roles/ Contributions of designers
53. Designers as visualizers of goals 54. Tool_Summary of Smart PSS 55. Tool_Mapping data stream 56. Tool_Building blocks	Visualizers of goals	Roles/ Contributions of designers

Appendix D: Scenario and measurement scales of final questionnaire for Study #3

1. Scenario

Just imagine you are a starting entrepreneur. You have recently started a company and are busy visiting potential clients for your business. You do not own a car yourself. However, you have recently learned about a rental car service, which particularly targets small/medium companies and entrepreneurs. The rental car service offers an alternative for car purchasing. As such, the company claims to be the perfect partner to portray the right image towards your clients.

You are interested in learning more about the rental car service. You go to the company's website to learn more about their offering. The website will help you create an opinion about the company, and to decide whether to get in touch to start a business relationship with it.

2. Scales

Attitude (based on Campbell and Goodstein, 2001)

In my opinion, the Renta Flex offering is:

1. 1=Bad/7=Good
2. 1=Unfavorable/7=Favorable
3. 1=Negative/7=Positive

Assurance level (based on Campbell and Goodstein, 2001)

1. I consider Renta Flex's offering to be a safe business decision (1=Strongly disagree/7= Strongly disagree).
2. I would feel confident if my clients saw me using the Renta Flex's offering (1=Strongly disagree/7= Strongly disagree).
3. I would feel assured about Renta Flex' support when needed (1=Strongly disagree/7= Strongly disagree).

Coherence

1. Renta Flex presents a coherent offering to its clients (1=Strongly disagree/7= Strongly disagree).
2. The offered car matched with the service that Renta Flex provides (1=Strongly disagree/7= Strongly disagree).

Appendix E: List of 11 preselected Smart PSSs for Study #4

#	Smart PSS (in alphabetical order)	Source
1	Fitbit	http://www.fitbit.com/uk
2	GreenWheels	https://www.greenwheels.com/global/
3	Hue	http://www2.meethue.com/en-us/the-range/hue/
4	Kindle	https://kindle.amazon.com/
5	Mimo Smart Baby Monitor	http://mimobaby.com/
6	Oral-B Pro 6000 Smart Series	connectedtoothbrush.com
7	Smart Baby Monitor	http://www.withings.com/nl/baby-monitor.html/
8	Smart Kid Scale (0-8 years)	http://www.withings.com/nl/baby-scale.html/
9	Smart body analyzer	http://www.withings.com/nl/smart-body-analyzer.html
10	Toon (Eneco)	https://www.eneco.nl/toon-thermostaat/?gclid=CKCmyb_6usECFQLJtAodqGcAFQ#navigatie
11	Withings Aura	http://www.withings.com/nl/withings-aura.html/

Appendix F. Overview of participants of Study #4

(Continued...)

(...Continued)

Participants	Gender	Age	Distinct characteristics of participants based on selection criteria
Fitbit #1	Male	48	How important is it for you to live a healthy lifestyle? (1 = Not important/5 = Very important) 5* How satisfied are you with the way you maintain a healthy lifestyle? (1= Not satisfied/5= Very satisfied) 2* How important is it for you to improve your physical condition? (1= Not important/5= Very important) 5*
Fitbit #2	Male	38	How important is it for you to live a healthy lifestyle? (1= Not important/5= Very important) 4* How satisfied are you with the way you maintain a healthy lifestyle? (1= Not satisfied/5= Very satisfied) 3* How important is it for you to improve your physical condition? (1= Not important/5= Very important) 5*
Fitbit #3	Female	54	How important is it for you to live a healthy lifestyle? (1= Not important/5= Very important) 4* How satisfied are you with the way you maintain a healthy lifestyle? (1= Not satisfied/5= Very satisfied) 3* How important is it for you to improve your physical condition? (1= Not important/5= Very important) 4*

(Continued...)

(...Continued)

Participants	Gender	Age	Distinct characteristics of participants based on selection criteria
Kindle #1	Female	49	How many hours, on average, do you spend on leisure reading in a week (including books, news, magazines, comics, etc.)? More than 9 hours/week. How do you get your reading material mainly? I buy books and magazines, I receive them as presents, I read material from work.
Kindle #2	Male	60	How many hours, on average, do you spend on leisure reading in a week (including books, news, magazines, comics, etc.)? Between 5 and 9 hours/week. How do you get your reading material mainly? I buy books and magazines, I borrow books from the public library, I borrow books and magazines from family and friends, I receive them as presents.
Kindle #3	Female	55	How many hours, on average, do you spend on leisure reading in a week (including books, news, magazines, comics, etc.)? More than 9 hours/week. How do you get your reading material mainly? I buy books and magazines, I borrow books from the public library.

(Continued...)

(...Continued)

Participants	Gender	Age	Distinct characteristics of participants based on selection criteria
Aura #1	Male	52	How satisfied are you with the quality of your sleep? (1= Unsatisfied/ 5= Satisfied) 2 How difficult or easy is it for you to fall asleep when you go to bed? (1=Very difficult/5=Very easy) 3 How rested do you feel in the morning when you wake up? (1= Not rested at all/5=Very rested) 3 How important is it for you to improve the quality of your sleep? (1= Not important/5=Very important) 4
Aura #2	Female	46	How satisfied are you with the quality of your sleep? (1= Unsatisfied/ 5= Satisfied) 2 How difficult or easy is it for you to fall asleep when you go to bed? (1=Very difficult/5=Very easy) 2 How rested do you feel in the morning when you wake up? (1= Not rested at all/5=Very rested) 2 How important is it for you to improve the quality of your sleep? (1= Not important/5=Very important) 4

(Continued...)

(...Continued)

Participants	Gender	Age	Distinct characteristics of participants based on selection criteria
Aura #3	Female	33	How satisfied are you with the quality of your sleep? (1= Unsatisfied/ 5= Satisfied) 2 How difficult or easy is it for you to fall asleep when you go to bed? (1=Very difficult/5=Very easy) 2 How rested do you feel in the morning when you wake up? (1= Not rested at all/5=Very rested) 1 How important is it for you to improve the quality of your sleep? (1= Not important/5=Very Important) 5
Hue #1	Male	36	How satisfied are you with the ambience of your home? (1= Unsatisfied/ 5= Satisfied) 3 How important is it for you to change the ambience of your home regularly? (1= Not important/5=Very important) 5
Hue #2	Female	25	How satisfied are you with the ambience of your home? (1= Unsatisfied/5= Satisfied) 3 How important is it for you to change the ambience of your home regularly? (1= Not important/5=Very important) 4

(Continued...)

(...Continued)

Participants	Gender	Age	Distinct characteristics of participants based on selection criteria
Hue #3	Female	49	How satisfied are you with the ambience of your home? (1= Unsatisfied/5= Satisfied) 1 How important is it for you to change the ambience of your home regularly? (1= Not important/5= Very important) 4

Appendix G. List of resulting codes, constructs and themes of Study #4

Code	Construct	Theme
1. Unpacking the product can have important influences on first experiences 2. Lack of instructions manual can influence experience	Orientation phase	Temporality of the user experience with Smart PSSs
3. Existence of several touchpoints within the system not always apparent 4. Users test claimed SPSS attributes 5. Users adapt behavior to the use of PSSs (learning how to interact with Smart PSS). 6. Understanding the system and its value takes more time than traditional products	From orientation to incorporation	Temporality of the user experience with Smart PSSs
7. Novelty of product wears down influencing use/exploration of SPSS 8. Exploration and understanding of the product is cyclic: Continuous growth	Incorporation	Temporality of the user experience with Smart PSSs

(Continued...)

(...Continued)

Code	Construct	Theme
9. Coherence of information matters 10. Completeness of information: detailed questions about functionality 11. Ambiguous information can influence trust/perception towards system 12. Accuracy of information is important 13. Continuous use influenced by accuracy of information 14. Having options can be overwhelming/ detrimental when consumers not guided 15. Need for guidance in relation to options: finding the right options that create value 16. Relevance of presenting information in a meaningful way	Quality of information	Factors affecting the transition from orientation to incorporation
17. Having/lacking options influences consumers perceptions/experiences with system 18. Positive attributes of service: empowerment 19. Integration with other products should be out of personal will, not enforced 20. Wider options, including third parties, means trusting other companies too 21. Options: important for the continuous use of the system	Number of options offered by the system	Factors affecting the transition from orientation to incorporation

(Continued...)

(...Continued)

Code	Construct	Theme
22. Coherent functionality of the system influences consumers perceptions 23. Integration with other products/ services should be seamless 24. Good functioning of Smart PSS dependent on other technologies 25. Continuous use influenced by flawed integration 26. Ease of use_ installation: influence experience 27. Ease of use_ contributing to coherence of functionality 28. Ease of use_ difficult use stops users from using Smart PSS as intended 29. Ease of use_ installation: Empowerment	Coherence of functionality	Factors affecting the transition from orientation to incorporation
30. Product attributes influence consumers experiences with the SPSS 31. Continuous use influences by product attributes	Product attributes	Factors affecting the transition from orientation to incorporation

Appendix H. Characteristics of Smart PSSs as a tool

1. Overview of characteristic

(Continued...)

1
CONSUMER EMPOWERMENT

- *Facilitating control*
- *Generating knowledge*
- *Promoting change*

Key Questions:
How important is it to expand the control of end-users, helping them make decisions and take action in their own terms?

- **FEEDBACK ON USER PROGRESS**
  - Measuring data
  - Tracking progress
  - Graphs and diagrams (from data to information

- **FEEDBACK ON STATUS OF PRODUCTS**
  - Tracking location
  - Checking availability

- **FEEDBACK ON QUALITY (PRIOR TO PURCHASE)**
  - Descriptions
  - Previews
  - Demos
  - Evaluative ratings

- **PROVIDING OPTION: GIVING CONTROL OVER CONTENT**
  - Extensive libraries with content
  - Creating own content

2
INDIVIDUALIZATION OF SERVICES

- *Addressing consumers as unique individuals*
- *Making consumers feel valued/listened to*

Key Questions:
How important is individualization in generating value for the end user?
At what level? At which point of their journey?

- **INDENTIFICATION OF CONSUMERS**
  - User accounts
  - Tracking consumer preferences

- **USE OF DIGITAL SERVICESCAPES**
  - Direct communication with end-user

- **CREATING EMPATHY**
  - Use of human-like tone
  - Fostering meaningful interactions
  - Defining the correct interaction level (e.g., automated vs real person)
  - Creating personalized communication

3 COMMUNITY FEELING

- *Enabling communication between users*
- *Fostering the creation of communities*

Key Questions:
How important for the use-context is it to facilitate the communication between end-users?
How important is it for such communication to be mediated by the system?

- **USE FEEDBACK FROM OTHER USERS**
  - Sharing experiences
  - Tips and tricks

- **CONNECTING AND SHARING INFORMATION**
  - Social media
  - Email
  - Forums

4
INDIVISUAL/SHARED EXPERIENCE

- *Enabling experiences that best match the needs of end-users*
- *Enabling a shared experience when appropriate through the Smart PSS*
- *Product use vs. system experience*

Key Questions:
To what extent should the system support the shared experience between users? At which level?
How central is it to the value proposition?

- **INDIVIDUAL USE, INDIVISUAL EXPERIENCE**

INDIVIDUAL USE, SHARED EXPERIENC

- **SHARED USE, INDIVIDUAL EXPERIENCE**

- **SHARED USE, SHARED EXPERIENCE**

5
PRODUCT OWNERSHIP

- *Defining the value of the physical product in the system*
- *Defining the responsibilities of the end user towards the product*
- *Exploring other types of non-physical ownerships*

Key Questions:
How important is the ownership of the tangible product?
Does the consumer have feelings of ownership over other aspects (e.g., content)?
What type of ownership is most relevant for the value proposition?

- **FULL OWNERSHIP**
  - Consumer considers the product a possession
  - Unlimited product access
  - Consumer responsible for maintenance
  - Individual product use

- **NO OWNERSHIP**

Consumer has no control over the product

- **TEMPORARY OWNERSHIP**
  - Limited product access
  - During use, the consumer is in charge of the product

- **OWNERSHIP OF CONTENT**

6
SERVICE INVOLVEMENT

- *Facilitating/promoting the recurrent/extended interaction between consumer and service provider*
- *Keeping consumers engaged*

Key Questions:
How can company and consumer benefit from the recurrent interaction?
To what extent should the interaction be supported by the e-service?
How often should it be?

- **PROMOTING DAILY OR WEEKLY INTERACTION**
- Gaming strategies

- **RENEWEING EXPERIENCE THROUGH CONTENT**

7
CONTINUOUS GROWTH

- *Envisioning and facilitating the growth/evolution of the system*
- *Maintaining value of the system relevant over time*
- *Implications for product development*

Key Questions:
How will the growth of the system be supported?
Where is the market heading, and can the Smart PSS support those changes?
What technology is needed to support future interactions?

- **INTRODUCING NEW CONTENT PERIODICALLY**

- **OPENING SYSTEM TO DEVELOPERS**

- **ENABLING CONSUMERS TO CREATE THEIR OWN CONTENT**

- **INTRODUCING NEW FUNCTIONALITIES**


Key Aspects:
Key Questions:
• EXAMPLES

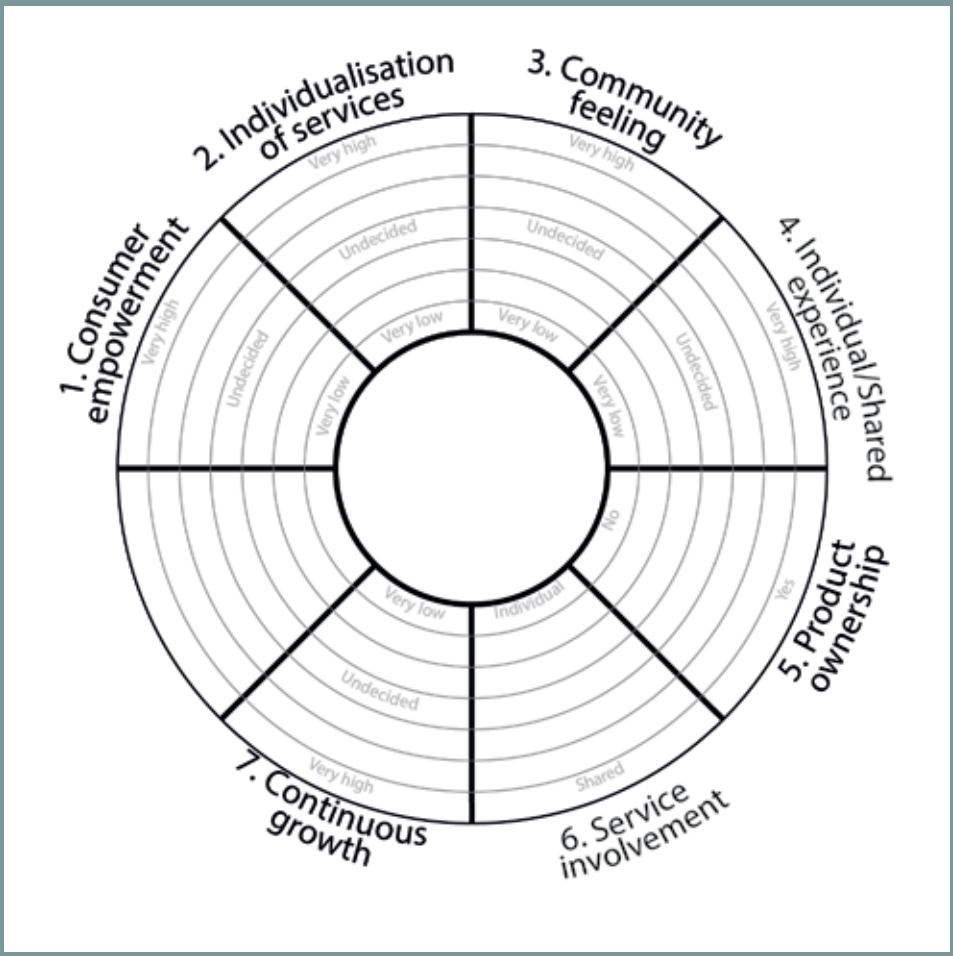
2. Reflection sheet for new value proposition

Name PSS: _____

Value Proposition:

1. Consumer Empowerment	2. Individualization of Services
3. Community feeling	4. Individual/Shared Experience
5. Product Ownership	6. Service Involvement
7. Continuous Growth	8. Other?

3. Wheel of characteristics



Aknowledgements

I would like to thank all the consumers who participated in the several studies presented in this thesis. Also, a special thank you goes to all the companies and professionals that took part in the research. This thesis would not have been possible without your valuable contributions. To our research partners: Jeroen van Erp, Merijn Hillen and Anna Offermans (Fabrique), Marte den Hollander (npk design), Marie Perez (Philips Design) and Onno van der Veen (Ideate). Thank you all for helping me reflect on the relevance of this work to industry and for your involvement through the several phases of this research project.

I would also like to thank the amazing group of design researchers who guided my through this process. To Jan, my promoter, I will always be grateful for your vision in research and direction. But most importantly, I will never forget your compassion. It was a true honor working with you. You thought me a thing or two about life; about priorities and the importance of family. To Ruth, my co-promoter, thank you for your discipline and dedication. Our story did not start with this project but back in the day when I was an undergraduate in Colombia. You guided my first research project, and by finishing this project, it feels like we have come full circle. You have played a key role in my formation as researcher, and this thesis has your imprint on it. You pushed me to raise the bar every step of the way and to not give up. Thank you for your openness and your encouragement when I most needed it.

To Rick, my project advisor, thank you for providing a different vision during our

research discussions. Also, thank you for having the doors of your office always open. I really enjoyed our chats about life and work. Towards the end you became more of a coach than an advisor. So thank you for listening and giving me some much needed advice. And Nata, we only worked together for a short but fruitful period of time. I would like to thank you for your contribution to Study #4, for walking me through new and interesting concepts, and for helping me to set up a research project that I'm very proud of.

Thank you to my wonderful colleagues at the PIM department. Even though I was not present all the time, you always made me feel welcome. To Erik Jan Hultink, thank you for helping my dream of studying in the Netherlands come true. You opened a big door for me and I will never forget the role you played in this story. To Dirk and Oscar, for helping me deliver my first academic research and nourishing my love for research. To Agnes, thank you for your diligent work, but specially, for being a friend and for caring. To our amazing secretaries at the time, Danielle and Leandra, thank you for helping me solve (sometimes) silly questions and to not get lost in the system.

To Valentin, Milene and Kasia; thank you for providing me with an office environment I loved. To Milene and Kasia, thank you for your friendship, which I value every day. We have laughed and cried together, about work and life. I know I can count on you and that is something I do not take for granted. I hope we can cry and laugh a bit more together in the years to come.

To Ehsan, thank you for the encouragement in the final phase of my PhD. Our work meetings and the library and our conversations really helped me to push forward. You are next!

To my friends: Lori, Angie, Cata, Caro, Michelle, Alejo, and most recently Lisa. You have encouraged me to finish my work one way on another and uplifted my spirits. Thank you for the good times and love.

Thank you to my family both in the Netherlands and in Colombia. To Ankie and Hans, there are no words that can express the love and appreciation that I feel for having you in my life. You have welcomed me in your family and have embraced my Latinness wholeheartedly. Thank you for your unconditional support and love. For your care of me but also of our little family. You made this process so much easier. Love you guys.

Mami, Papi, hermanito, gracias por estar presente a pesar de la distancia, por apoyarme incondicionalmente todos estos años. Los amo eternamente y no hay un momento en que no los extrañe. Papi, gracias por inculcar en mi la apreciación por la educación y la lectura. Mami, gracias por ser mi modelo a seguir, por ensenarme lo importante que es la ética profesional y la perseverancia. Todos los días aprendo de ti y nunca deja de sorprenderme tu energía y amor por el trabajo. Gracias por tu apoyo emocional todos estos años, por tu paciencia y entendimiento.

Finally, to my two boys. Jaap, the love of my life, my best friend, my rock. I love you so very much. You have listened patiently, and embraced me with all your love whenever I felt vulnerable. Together we are strong, and this achievement is as much mine as it is yours. Thank you for all the years we have been together, for your strength and loyalty. I am a better person today because of you. To León, mi chiqui, mi proyecto más importante. Esta tesis esta dedicada a ti. Tu eres la razón por la cual perseveré cuando estaba lista a renunciar. Gracias por tus dulces abrazos y tus sonrisas, por tu amor incondicional. Todos los días me das grandes lecciones de vida, nada me hace mas feliz que tenerte en nuestras vidas. Te amo.

About the author

Ana Valencia was born in Medellin, Colombia (1981). There, she obtained her degree in Product Design Engineering (EAFIT University). Her interest in research started as an undergraduate in Colombia where she researched the readiness of Colombian consumers for mass customized products through online platforms. Ana has over seven years of experience in the design and implementation of qualitative/quantitative research for market and consumer studies. In 2006, she moved permanently to the Netherlands where she pursued her master degree in Strategic Product Design (TU Delft). There, she deepened her knowledge and interest in research. Through her academic research and several industry internships, she obtained an increased awareness of the importance of design and its management for creation of products and services of value to consumers. She subsequently worked in industry as a market researcher and analyst. As of 2011, Ana has worked as a PhD candidate and students' coach at the Product Innovation Management department of TU Delft. During her research, she was able to bring together her research interests, such as service design and design management, and how they can be used to create meaningful experiences for consumers. Ana currently resides in The Netherlands with her husband and son. After her PhD, she will continue in the field of Product-Service System design and contribute to the creation of value propositions with a positive impact for society.

Publications

Academic Journals

Valencia, A., Mugge, R., Schoormans, J. P. L., & Schifferstein, H. N. J. (2015). The design of Smart Product-Service Systems (PSSs): And exploration of design characteristics. International Journal of Design, 9(1), pp. 13-28.

Valencia, A., Person, O., & Snelders, D. (2013). An in-depth case study on the role of industrial design in a business-to-business company. Journal of Engineering and Technology Management, 30(4), pp. 363-383.

Conferences

Valencia, A., Mugge, R., Schoormans, J. P. L., & Schifferstein, H. N. J. (2014). Challenges in the design of Smart Product-Service Systems (PSSs): Experiences from Practitioners. Proceedings of the 3rd Cambridge Academic Design Management Conference, Cambridge, United Kingdom.

Valencia, A., Mugge, R., Schoormans, J. P. L., & Schifferstein, H. N. J. (2013). Distinctive Characteristics of Smart PSSs. Proceedings of the 5th International Congress of International Association of Societies of Design Research, Tokyo, Japan.

Valencia, A., Mugge, R., Schoormans, J. P. L., & Schifferstein, H. N. J. (2013). Characteristics of Smart PSSs: Design Considerations for value creation. Proceedings of the Design Academic Management Conference, Cambridge, United Kingdom.

Valencia, A., Mugge, R., Schoormans, J. P. L., & Schifferstein, H. N. J. (2011). Designing a Product Service System: Does congruity add value? Proceedings of the Design Academic Management Conference, Cambridge, United Kingdom.

Invited Presentations

03/2014	KLM In-flight Congress: "The design of Smart PSSs: Design consid erations for value creation." Schiphol, the Netherlands.
10/2013	IDE Service Design Master Class: "About products, services, and product-service systems: Challenges for designers." Delft, the Netherlands.
	Get a Grip Symposium 2013 at Scope Design and Strategy – Prod uct Service Systems: "The What and How of the design of Smart PSSs: Two stories." by Kasia Tabeau and Ana Valencia. Amersfoort, the Netherlands.
	CRISP Design Review Session 5: "The characteristics of Smart PSSs as a tool for practitioners." Eindhoven, the Netherlands.

03/2011 Coming to Business: “How do managers of a business-to-business company look at industrial design?” Eindhoven University of Tenology.

This thesis investigates the design of ***Smart Product-Service Systems (Smart PSSs)***, defined as the integration of smart, connected products and e-services, presented to consumers as single solutions to satisfy their needs.

The aim of the thesis is to provide designers and design managers with guidelines and insights, which can aid the design and implementation of Smart Product-Service Systems (Smart PSSs) with increased and lasting value for companies and consumers.

Three research questions are investigated: ***What set of design characteristics can designers use while defining Smart PSS value propositions? How can designers support the design process of Smart PSSs?*** And, ***How can designers trigger positive consumer responses with Smart PSSs?*** These questions are investigated by means of four qualitative and one quantitative studies.

The thesis follows a multidisciplinary research approach, building from theories of different fields, such as operations management, design management, service design, and traditional PSS design. Furthermore, research findings are translated into ten design guidelines (practical Do's and Don'ts) for Smart PSS design.