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Essays on smart customization: Towards a better understanding of the customer's perspective on smart customization offers

Morgane Benade

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THÈSE DE DOCTORAT

de l'Université de recherche Paris Sciences et Lettres
PSL Research University

Préparée dans le cadre d'une cotutelle entre
MINES ParisTech et RWTH Aachen

Essays on Smart Customization: Towards a Better Understanding of the
Customer's Perspective on Smart Customization Offers

**Essais sur la « Smart Customization » : Vers une Meilleure
Compréhension de la Perspective Client Relative aux Offres de
Smart Customization**

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Spécialité Sciences de Gestion

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In loving memory of my grandmother Marie Lameul Gicquel (1921-2017)

Summary

In the last decade, consumer products have been equipped to an increasing extent with information and communication technology (ICT) in a form of sensors, software, microchips and other types of electronics, which has greatly changed the nature of their applications (Rijsdijk & Hultink, 2009). Notably, firms finally find a mean with such technology to empower customers to customize their products after purchase. I call this approach in my research “Smart Customization”. Three forces drive it that are: an increasing growth of data volumes and computational power and connectivity, the rise of analytics and business intelligence so as the emerging forms of human-machine interaction (Baur & Wee, 2015; Bechtold, Kern, Lauenstein & Bernhofer, 2014; Thomke, 2016).

For such smart customization to happen, the idea is to embed directly some smart user toolkits for co-design (smart UTCD) made out of ICT components in our consumer products. These smart UTCD that consist principally of software tools and data elements can be viewed as – referring to their most basic versions – a CAD system, but with a friendly user interface and a library of modules and functionalities (Piller & Salvador, 2016). In the seminal publications of von Hippel (Thomke & von Hippel, 2002; von Hippel, 2001; von Hippel & Katz, 2002), they are conceptualized as some sets of complementary design tools that assist customers to customize unfailingly a product via (1) a trial and error process and (2) a direct feedback on the creation outcomes. Compare to mass customization (i.e. a mass customized production of a previously configured product realised online by customers with non-tangible UTCD i.e. online configurators), the advantage of smart UTCD lies in the fact that they finally provide the right capabilities to customers to co-design / customize their products with a real and continuous learning effect (Gross & Antons, 2009). That is, such systems finally permit customers to test their various custom designs in a real usage situation until they finally opt for the one they prefer the most. A pioneering application is the Adidas One. Adidas proposes sneakers that integrate smart UTCD in the cushioning parts. See Figure S.1. below.

By means of smart UTCD that consist of a software, microprocessor, sensor and a small console plus and minus that offers five factory-setting gradients, customers have the possibility to customize the midsoles' compression characteristics according to their weights, their running styles or terrains.



Figure. S.1. Adidas One
Source: sneakersaddict.com

That said, while in the business press, smart customization is largely viewed as an opportunity to be tapped (Bechtold et al., 2014; Ernest-Jones, 2008; Porter & Heppelmann, 2014), in contrast, research is hardly focused on it (Piller, Ihl & Steiner, 2010; Thomke, 2016). Despite some early work realized by von Hippel on the concept of UTCD for customization (von Hippel, 2001; von Hippel & Katz, 2002), such research is still described as “emerging” (Thomke, 2016). Notably, our understanding of the customer’s perspective on UTCD has been stated for years to be rather limited (see, e.g., Franke & Piller, 2003; Thomke, 2016). Yet, it is essential to identify factors of customer-based success of customization offers via UTCD (Ihl, 2009). Prior research on mass customization has begun to explore various perspectives to address the topic, that is, from the perspectives of the technology acceptance to the customer’s choice process that leads him/her to select a specific customization offer’s format (see, e.g., Dellaert & Dabholkar, 2009; Piller et al., 2010). In light of this groundwork, a comprehension of the customer’s perspective on smart customization offers with a focus on smart UTCD appears necessary (Thomke, 2016). It is, in fact, a first step in this area of interest, given that one witnesses just the beginning of some promising research avenues on the smartness, adaptability, connectivity that are consumer products are currently turning into (Marketing Science Institute, 2016; Rijdsdijk, 2006). In what follows, are concise summaries of three papers that compose my dissertation.

In the first article entitled “*Smart Customization a Realistic Alternative to Mass Customization?*” I introduce the concept of smart customization and present it as a possible alternative to mass customization. Especially, I highlight the fact, based on the work of Franke & Hader (2014) and Simonson (2005), that customers with no understanding on how they want their products to be customized, are more likely to learn it thanks to smart customization. That

is, they have the possibility to test the various custom designs in a real usage situation until they find one that suits them the best. Yet, rare are the applications of customization via smart UTCD. Thus, as a first step in this research, to investigate the customer acceptance is desirable. To do so, I extended previous research on customization offers (e.g., Guilabert, 2005; Piller et al., 2010; Simonson, 2005) by investigating the customer's intention to utilize smart UTCD and its contingent factors. In details, I adapted and tested a technology acceptance model that links the customer's perceptions on smart UTCD and the customizable product to the customer acceptance. Additionally, I added two more factors related to the customer's personal traits from the research of Simonson (2005) that permit to identify the groups of customers that accept smart customizable products with smart UTCD. Then, resulting from the structural equation modelling of 263 panellists from the car product domain and 250 respondents from the mobile phone one, I validated all the hypotheses I made in the model - except one. In so doing, I confirmed that the acceptance is largely influenced by the customer's perceptions on smart UTCD. Additionally, it permits me to unveil the almost as large segments of customers as for mass customization ready to use smart customizable products. With these outcomes, the article contributes to theory and practice by adding to our limited understanding of the smart UTCD acceptance and by providing producers with practical implications to meet the customer acceptance.

In the second article entitled "*Conceptualizing Smart User Toolkits for Co-design in Accordance with Customer Preferences*", I argue that it is important to understand how customers select one smart UTCD format over another, given that smart UTCD have the singularity to be tangible tools embedded directly in consumer products. Notably, I aim at investigating whether or not the customer's decision-making process for a smart UTCD can lead to some adjustments on their formats for a better adoption. Prior research linked to mass customization has begun to address such topic by examining, for instance, to which extend customers prefer one format of a mass customization offer over another and their impacts on the utility of the customization process or of the customized product (e.g., Dellaert & Dabholkar, 2009; Ihl, 2009). In this paper, I intended to contribute to such literature by shedding light on the importance of certain smart UTCD' design features from the customer's

perspective, without affecting the functional benefits of these tools. By building on the consumer choice theory (McFadden, 1986), my central premise is that the customer's latent utility for a certain smart UTCD is affected by its design attributes and the customer's personal traits. To test this theory, I realised a choice based conjoint analysis on smart UTCD for mobile phones. Resulting from an analysis of 250 mobile phone owners, my findings confirmed all the hypotheses I made. In particular, I revealed that, next to data privacy, the help functions and the visual aspects of smart UTCD are the two design features that affect the most the customer's decision-making process for a specific smart UTCD format. Finally, I unveiled some differences in function of the customer's personal traits concerning the format of smart UTCD. Altogether, I contributed to theory by providing in-depth knowledge on the customer preferences on the smart UTCD' design features and by conceptualizing smart UTCD further in accordance with the customer preferences. For producers, I derived a set of judicious design tactics that permit them to develop an adequate smart UTCD i.e. not uniquely effective but also attractive that vary in function of the target customers.

In the last article entitled "*Interaction Patterns of Smart User Toolkits for Co-design with Customers for Individual Uses of Products*", I seek to provide the interaction patterns of smart UTCD to co-design with customers their optimal solutions. Already in 2003, Frank & Piller (2003) mentioned that it is an essential research aspect in customization. They, notably, mention that the problem is rooted in our lack of understanding of the co-design mechanisms that are involved in the customers-smart UTCD interactions. Thereby, to address this issue, I expose for the first time in this field of research, a theoretical framework of use generation (Brown, 2013). The latest comes from another domain of research, that is, the one of design theory and methods for innovation. In details, I applied the framework of use generation on the two types of smart UTCD described in the literature (e.g., von Hippel, 2001; von Hippel & Katz, 2002). In doing so, it permitted me to expose the mechanisms of co-design, identify the nature of these mechanisms via the literature related to design theory and pinpoint the difficulties that occur between customers and smart UTCD. Then, with these outcomes, I suggested some measures in a form of additional services for support and supervision (i.e. tutorials of a few uses of smart UTCD, etc.) under which the co-design mechanisms are more effective (i.e. interaction

patterns). So how did my research contribute to theory and practice? I made use of modern design theory for the first time in this research area to open the black box of the co-design mechanisms that occur between customers-smart UTCD. Moreover, I proposed additional services along with smart UTCD that focus on increasing the effectiveness of the co-design processes with customers, which especially permit firms to develop the right smart customization offers i.e. products with smart UTCD and their associated services.

Altogether, the results of my three articles jointly contribute to a more holistic and balanced assessment of smart customization offers from the customer's perspective. Especially, they are not only of theoretical importance but also of managerial relevance. Next to attempting to fulfill the research gaps found in the smart customization literature, such findings permit to support firms to tap the opportunity of smart customization by providing them with some in depth-knowledge to design smart customization offers that fit better the various target customers prior to their launches.

Résumé

Au cours de la dernière décennie, les technologies de l'information et de la communication intégrées aux produits de consommation ont considérablement modifié la nature de leurs usages. Réactives, les entreprises se sont emparées de ces nouvelles technologies et proposent aux consommateurs de customiser leurs produits quotidiens après achat.

J'ai intitulé cette approche "Smart Customization", dans ma thèse. L'idée étant que, pour qu'une telle customisation "intelligente" ait lieu, il faut intégrer directement des boîtes à outils intelligentes (ou smart UTCD) dans nos produits de consommation. Ces boîtes à outils intelligentes sont ensuite destinées à guider les consommateurs dans le procédé de customisation de leurs objets.

Actuellement, il n'y a pas véritablement de recherche académique alors que la presse industrielle évoque la smart customization comme une opportunité à exploiter. Il semble pourtant essentiel, outre le fait de conceptualiser cette approche, d'identifier les facteurs de succès de ces nouvelles offres de customisation, en adoptant le point de vue du consommateur sur l'élément principal Smart UTCD.

C'est ce qui a déterminé l'objectif de ma thèse. Via une étude d'acceptance technologique dans le papier 1, un choice based conjoint analysis dans l'article 2 et une exploration des mécanismes de co-conception qui ont lieu entre le consommateur et l'outil de conception « smart UTCD », je participe à la recherche sur la smart customisation. Egalement, cette recherche permet de proposer des tactiques de design aux industriels afin que leurs offres de smart customisation soient parfaitement adaptées au client cible.

Thesis Structure Overview

My dissertation has two parts. In part I, it is composed of an introduction, a theoretical and conceptual review, the articles' summary, plus a discussion and a conclusion. In part II, there are the three articles which all relate to the general topic of this dissertation: "Towards a Better Understanding of the Customer's Perspective on Smart Customization Offers". It investigates the customer's point of view of such new approach via the principal elements i.e. smart UTCD. Previous versions of the three articles that compose this dissertation were presented at international conferences so as doctoral research seminars. The following section gives readers an overview about them.

Article I – Smart Customization a Realistic Alternative to Mass-Customization?

Presentations:

- Technology and Innovation Management Chair Doctoral Seminar, School of Business and Economics, RWTH Aachen University, September 2013
- Open and User Innovation Workshop, University of Brighton, August 2013
- Centre de Gestion Scientifique Doctoral Seminar, Mines ParisTech, November 2013

Article II – Conceptualizing Smart User Toolkits for Co-design in Accordance with Customer Preferences

Presentations:

- Technology and Innovation Management Chair Doctoral Seminar, School of Business and Economics, RWTH Aachen University, September 2013
- Centre de Gestion Scientifique Weekly Meeting, Mines ParisTech, November 2015
- Mass Customization & Personalization Conference, RWTH Aachen, November 2017

Article III – Interaction Patterns of Smart User Toolkits for Co-design with Customers for an Ultimate Solution

Presentations:

- Institute for Production Systems and Design Technology Doctoral Seminar, Fraunhofer IPK, April 2017
- SIG Design Theory, Mines ParisTech, January 2015
- Open and User Innovation Conference, Harvard Business School, August 2016

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Abbreviations

AVE	Average Variance Extracted
CBCA	Choice-Based Conjoint Analysis
C-K	Concept-Knowledge
FF	Feature Fatigue
ICT	Information and Communication Technology
ML	Maximum Likelihood
PCOU	Perceived Complexity of Use
PE	Perceived Enjoyment
PI	Preference Insight
PLS	Partial Least Squares
PPC	Perceived Product Customization
PU	Perceived Usefulness
PV	Preference Variability
SEM	Structural Equation Modelling
TAM	Technology Acceptance Model
UTCD	User Toolkits for Co-design

**Part I: Introduction, Summaries of the Three Articles,
General Discussion, Conclusion and Limitations for
Further Research**

Introduction

Customers, whether consumers or businesses, do not want more choices. They want exactly what they want - when, where and how they want it (Pine, Peppers & Rogers, 1995, p. 103)

With the progress in the production and communication technologies, some scholars announce new possibilities as the start of a new era in business (Cook, 2008; Prahalad & Ramaswamy, 2004; von Hippel, 2005). That is sooner or later, one of the possibilities, so they foresee, is to finally apply a basic principle of marketing which is to give customers exactly what they want (McKenna, 2002). In fact, firms have been lately challenged to change their old, inefficient ways to develop products and make use of the new technologies to propose customization offers that respond better and faster to each of the customer's individual needs (Simonson, 2005).

Among several approaches, one of them applies the notion of customer co-creation where customers and firms are co-designers of some products that suit exactly what customers want (Udwadia & Kumar, 1991). The idea was applied in the management domain when von Hippel (1994; 1998) reveals the issue of the "sticky" information in the development of a product. It is defined as needs related information not effortlessly transferable in the form usable from the customer's recipient to the firm's one in the product development. To solve this issue, von Hippel (2001) applies the notion of customer co-creation so that the "sticky" information related design task can be entirely shifted to customers. It does so, by proposing to equip customers with UTCD so that they are empowered to transform their needs into concrete solutions (Piller & Salvador, 2016).

Ever since, UTCD have been extensively used in the mass customization strategies. That is, the approach consists of mass-producing a previously configured product realised by customers by means of UTCD provided by the producers (Pine, 1993). Yet, despite the general enthusiasm for mass customization across industries (Nestle, Dell, BMW, General Motors, etc.), the capacity is stated for years to be rather limited (von Hippel & Katz, 2002). For one thing, UTCD cannot provide customers feedbacks of their custom designs other than by computer

simulations. Thereby, it is a challenge for certain customers to customize without having the possibility to perform a trial and error experimentation, which is particularly problematic for rather utilitarian products. Additionally, another limitation is that customers have to wait several weeks before having their customized products delivered to them. Consequently, there is a risk that customers no longer want to have them; especially knowing that customer's needs change too rapidly (Rosenberg, 1982).

Fortunately, with the progress of ICT in consumer products, an alternative was suggested in the business press (see, e.g., Ernest-Jones, 2008; Porter & Heppelmann, 2014). The idea is to equip directly consumer products with some smart UTCD. That is, such smart sets of design tools composed of data elements and software have the advantage to support customers to test directly their creations in the usage stage of the products they own i.e. with some real and continuous learning effects (e.g., Gross & Antons, 2009). In fact, various early adopters already show their potentials. In the mobile phone industry, for instance, some producers have lately developed smart UTCD i.e. the Tasker or Wiz connected light to empower customers to customize the phone's functionalities or the lighting of their houses. Actually, industrials believe that the maturity of smart UTCD will lead to their proliferation (Ernest-Jones, 2008). For instance, nowadays, many institutes i.e. MIT and firms like Philips have already focused on conducting studies on smart UTCD (Rijsdijk & Hultink, 2009).

Yet, despite the "smart customization" hype within industries, research on its main element, meaning, UTCD is still emergent (Thomke, 2016). Notably, while the focus is on the firm's perspective i.e. technical aspects, production environments, costs, etc., in comparison, our understanding of the customer's perspective is rather limited, the latter being surprising (Franke & Piller, 2003; Piller & Salvador, 2016). Indeed, as these customization methods occur only with the customer's deep involvement (Udwadia & Kumar, 1991), unless there is a better comprehension on the factors of customer-based success on smart customization offers, the consequence is that firms will not be able to succeed with these offers (Ihl, 2009).

Following this, I aim, in this dissertation, at fulfilling partly this research gap. I do so by conducting three studies on the customer's perspective on the principal elements of smart customization i.e. smart UTCD. Beyond the theoretical importance, it should additionally

permit firms to develop smart customization offers that succeed in the market place. That is, it should provide them with measures to better create and identify smart customization offers for their target customers. I acknowledge, though, that this research is futuristic to a certain extent. Even though the business press foresees that smart customization is likely to be applied in the near future (e.g., Bechtold et al., 2014; Ernest-Jones, 2008; Porter & Heppelmann, 2014), it is still at an early stage. Nowadays, they exist on the small scale and do not always look like a proper smart UTCD.

So, it is to this setting that I investigate the smart UTCD' customer acceptance in Article I, the customer preference structure on smart UTCD' design in Article II, so as the smart UTCD' interaction patterns of customization with customers in Article III.

First, about the smart UTCD acceptance, it is shown in many empirical studies that it is necessary to explain the customer acceptance, once a new class of products emerges in the market (see, e.g., Davis, 1989; Davis; Bagozzi & Warshaw, 1992). Various studies in the context of mass customization offers demonstrated that it is worth doing it (see, e.g., Fiore, Jin & Kim, 2005; Fiore, Lee & Kunz, 2004; Piller et al., 2010). Yet, little is known about the smart UTCD acceptance. As smart UTCD and UTCD share common characteristics but intervene at different points in the customization process, results are likely to not be the same. Accordingly, I formulate the first research questions: Do customers accept Smart UTCD? What are the determinants of the Smart UTCD acceptance? Are there differences with UTCD acceptance?

Second, concerning the smart UTCD' design features, marketing research started to shed light on the importance of understanding how diverse customers may or may not be attracted by these tools (see, e.g., Dellaert & Dhabolkar, 2009; Randall, Terwiesch & Ulrich, 2005). Yet, compare to research on the UTCD' functional aspects, that is, to assist customers in the customization process, literature that focuses on the customer's perspective on the UTCD' design format remains scarce (see, e.g., Franke & von Hippel, 2003; von Hippel, 2001; von Hippel & Katz, 2002). In particular, for Randall et al. (2005), it is surprising, given that customization is based on the evidence that customer needs are heterogeneous, which therefore, means a standard customization offer is not enough. Thereby, it is essential to address this topic. Notably, knowing that smart UTCD have the singularity to be consumer products; it is a crucial

research aspect to consider i.e. one has to consider the customer's attractiveness for these tools. Consequently, in what follow are my second research questions: What are the smart UTCD' design features that influence the customer's decision-making process? Are there key features to develop further the concept of smart UTCD in function of the customer preferences?

Finally, concerning the interaction patterns of smart UTCD, Franke & Piller uncovered already in 2003 that they are blurred, which lead, in turn, customers to fail in the customization process. Notably, Jeppesen (2005) reveals that it is particularly problematic for the high-end UTCD, which require greater "innovative design" skills from customers. Franke & von Hippel (2003), in fact, illustrate it well with the Apache Software, employed by maximum 37% of the customers; the remaining feeling incapable of customizing. As mentioned by Franke & Piller (2003), the problem is definitely rooted in our lack of understanding of the co-design mechanisms that occur between customers and smart UTCD. So far, nobody could open the black box on these mechanisms and so propose some adequate interaction patterns. Following this, I elaborate the third research questions: How to understand in details these mechanisms? What are the natures of these mechanisms and the associated difficulties that occur? Under which measures can these mechanisms be more effective i.e. interaction patterns of smart UTCD?

This dissertation addresses these research questions by means of three articles. In Article I, I adapted a technology acceptance model (TAM) and so empirically examined the influence of the customer's perceptions on smart UTCD, on the product he/she owns so as their personal traits on the smart UTCD acceptance. Article II, then, examined the customer's choice process in function of the smart UTCD' design features of smart UTCD. The study is proper to smart UTCD, as they have the uniqueness in comparison with other UTCD to be consumer products. Therefore, it is essential to conceptualize them further in accordance with the customer preferences. Last, article III focuses on understanding in details the co-design mechanisms that occur between customers and smart UTCD. In so doing, it permits me to identify the natures of these mechanisms and the associated difficulties that occur, which in turn enables me to provide additional services within smart customization offers so that the mass can obtain their ultimate designs or solutions i.e. interaction patterns of smart customizaiton offers. Article I and II are

empirical studies, while Article III addresses the research questions by making use, for the first time in this research, of the theoretical framework for use generation (Brown, 2013). The latest was developed based on the canonical model explained recently by Le Masson, Weil & Hatchuel (2017).

The remainder of the dissertation is structured in two parts as follows: In part I, I provide a literature review of UTCD from the firm's and customer's perspective in the context of customization offers. Then, I summarize concisely each of my three articles, in which I present the research gaps relevant to this thesis and motivate my research. Then, I discuss the overall results, underline the contributions to the literature and pinpoint implications for practitioners. Next, I finalize with the limitations of this research so as I suggest future research that might be of high interest for researchers who are motivated to pursue their academic works in this promising field. Finally, the second part of this dissertation comprises the three stand-alone papers that focus respectively on the three research aspects mentioned above.

Theoretical and Conceptual Background

User Toolkits for Co-design and Sticky Information

Marketing research shows that products must respond to the customer's individual needs if they are to succeed in the market (McKenna, 2002). Up till now, firms frequently conduct market research techniques with customers to gather information related to these needs (Franke & von Hippel, 2003). However, they often have to make an effort to acquire the right information as the latest are too often ill defined, incomplete or subject to rapid changes (Rosenberg, 1982). Thereby, to obtain the right information, firms often engage in a process with their customers of shifting back and forth needs related information until the adequate ones are acquired (von Hippel & Katz, 2002). von Hippel (1994; 1998) talks about the problem of the "sticky" information in the development of a product. The author describes it as a piece of information difficult to transfer in the form usable from the customer's recipient to the firm's one. Accordingly, to tackle this issue, it makes only good economic sense for firms to develop products that satisfy the average-needs of their customers (Franke & von Hippel, 2003). Recently, though, more and more firms have decided to serve the "market of one" due to the growing heterogeneity of the customers' needs, the dynamic demands and the advanced technologies (Franke & von Hippel, 2003; Simonson, 2005).

Among several approaches attempting to realise it, one proposed by von Hippel (2001) is to make use of the notion of co-creation by equipping customers directly with UTCD. Via these sets of design tools, firms no longer have to spend time and money to comprehend in details the customer needs but instead, delegate the full design task connected to the "sticky" information entirely to customers. With UTCD, the idea is that customers, notified of all possible combinations, test some of them, learn what they want from them and reiterate the process until they uncover what they exactly want. That is, customers are thoroughly guided through an iterative experimentation to transform their latent needs into a concrete solution (Piller & Salvador, 2016). As Wind & Rangaswamy (2001, p.15) posit, "UTCD' focus is to help customers to better identify or define for themselves what they want".

Furthermore, von Hippel (2005) proposes that all UTCD share the following five characteristics:

- Some full cycles of trial and error that guide customers to their ideal solutions
- A solution space that encompasses what customers want
- Being user friendly so that they are easily operated
- A library of modules that empowers customers to co-design their solutions
- Some design outcomes producible by firms.

Finally, there are variants of UTCD, which exist in the market place. Referring to Thomke & von Hippel (2002), the scope, that is, the offered design possibilities, is one element that differentiates them. Franke & Schreier (2002), based on this criterion, describe then two types i.e. high-end and low-end toolkits. That is, high-end toolkits possess a wider scope, which permits customers to combine relatively basic and general-purpose building blocks and operations i.e. Lego Mindstorms, while low-end ones enable users to select a few predefined options from lists i.e. Adidas One. Thus, it requires – nowadays to a more or less extent – greater design skills from customers to employ the high-end ones (Prügl & Schreier, 2006).

Mass Customization Offers

In mass customization, the pivotal idea of von Hippel (2001) with UTCD is largely used (Piller & Salvador, 2016). The approach uses UTCD – often low-end ones – made available on the firm's website to retrieve the exact virtual customized product realised by their customer. Once the firm retrieves it, it effortlessly produces it with the various combinations of computerized production machines so as delivers it to the client. The principal advantage of this method is to propose customers a customized artefact at a cost that is reasonably competitive (Pine, 1993). Moreover, what characterizes mass customization offers is the hedonic nature of UTCD, which plays a major role in the customization process. Van der Heijden (2004), notably, mentions that it permits customers to prolong their uses and subsequently increase the probability they obtain a product with a closer preference fit. In fact, other scholars emphasize the importance of the hedonic aspect by showing in their empirical studies that, the fun customers derive from the experience of co-designing with UTCD, is an important side effect of mass customization (see,

e.g., Franke & Schreier, 2010; Schreier, 2006). Producers, actually, take advantage of it within product domains as different as foods (mymms.de), sport equipment (Adidas.com/us/customize) or vehicles (mini.com).

But, despite the general interest for mass customization, a few academics started to show concerns about certain downside effects of this method (Bharadwaj, Naylor & ter Hofstede, 2009; Kramer, 2007; Simonson, 2005; Syam, Krishnamurthy & Hess, 2008). Their argument, supported by an earlier research in consumer decision-making (e.g., Loewenstein & Prelec, 1993; Tversky & Kahneman, 1981), is that, even though it is attractive to all customers, it is not well suited for all of them. That is, customers with insight into their preferences are perfect for mass customization, but, the others who do not have well-defined, stable needs – considered in majority in product domains – are likely to be disappointed with the mass customization offers (Bharadwaj et al., 2009). As Syam et al. (2008) state it is somehow confusing to ask such customers to articulate their unknown needs in the customization of their product. Yet, more recently, other researchers show their disagreement by demonstrating that mass customization is not limited to certain customers, but it is for all (Franke & Hader, 2014; Moreau, Boney & Herd, 2011; Payne, Storbacka & Frow, 2008). They claim, since UTCD act like “learning instruments”, there is no need to limit mass customization offers to a small group of customers. For them, UTCD are purposely developed to support customers to define and identify for themselves what their preferences are...but it is still to a limited context. For years, mass customization offers have been seen as possessing limited capacities (von Hippel & Katz, 2002). First, it does not permit to test the various designs other than via computer simulations, which is rather problematic for utilitarian goods. Unless customers can try them out in a real usage situation with an effective learning effect, there is a risk that customers who do not have stable, well-defined preferences are unsatisfied with the customized product delivered to them. Second, with such method, producers are constrained to deliver the customized products after a few weeks (for Mi Adidas, 3-5 weeks). Consequently, there is an additional risk that the delivered product no longer suits the customer, which results in flops for firms proposing them (Simonson, 2005). Fortunately, with the advent of smart products, there is a novel approach of customization. Since then, customization is reinvigorating.

Smart Customization Offers

In tomorrow's industry, products will more and more become smart, connected products, especially, with the applications of ICT such as hardware, sensors, microprocessors or software (Porter & Heppelmann, 2014; Rijdsdijk & Hultink, 2009). Notably, a growing number of firms currently orient their products towards cyber-physical systems that offer novel features based on connectivity (Bechtold et al., 2014). Among all, one could observe the emergence of smart UTCD systems composed principally of data elements and software (Ernest-Jones, 2008; Gross & Antons, 2009; Thomke, 2016). With these systems embedded into products, the idea is finally to give customers the right settings to test and create their custom designs in a real usage situation i.e. what mass customization could not offer. Further, beyond it, they have all a shared capability, which is to permit customers to customize constantly their artefacts for a specific usage situation (see, e.g., Gross & Antons, 2009; Piller et al., 2010). Therefore, these offers seem better suited for customers who do not have well-defined and stable preferences as they finally enable them to have real and continuous learning effects of their created outcomes. Notably, given that needs are defined and shaped within the context customers are in (for review see, e.g., Bettman, Luce & Payne, 1998; Fischhoff, 1991; Slovic, 1995), such customers are likely to obtain what they exactly want from customization. For a better understanding of the smart customization approach in comparison with the mass customization one, see Figure I.1.

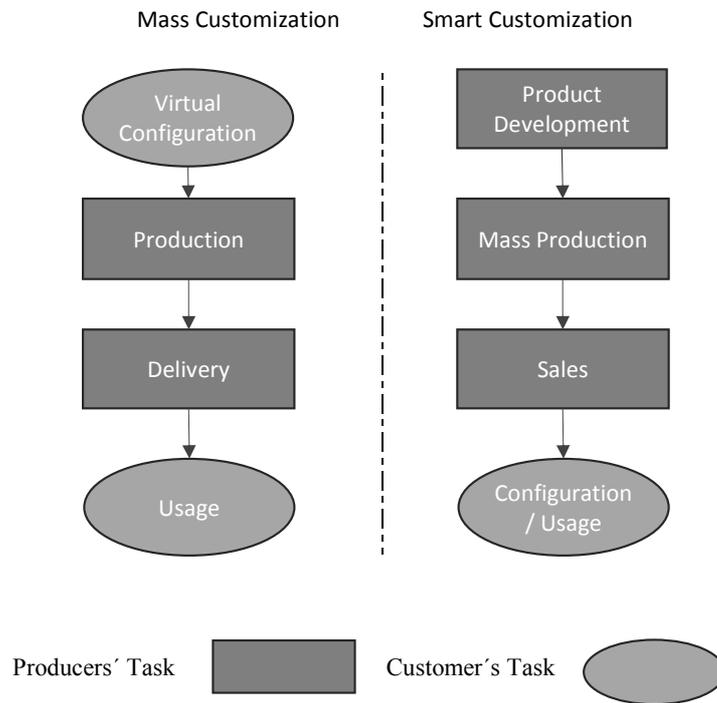


Figure I.1. Mass Customization Versus Smart Customization

Nowadays, some pioneering applications already exist of smart customization. In the light industry, for example, Philips proposes a low-end smart UTCD called “Hue” that centralizes, coordinates and customizes the connected lighting of a house. By means of it, users can adapt the brightening, the colors of the connected bulbs so as the energy in accordance with the time of the day, the room or other connected objects i.e. Alexa. Besides, they also have the possibility to save sequences, such as a routine morning having the purposes to reduce the energy bill, enhance the mood or just have an appealing, dynamic ambiance. About the high-end smart UTCD, Lego proposes recently one of them, which is the Lego Mindstorms. With these toolkits composed of ICT components such as sensors, connected blocks, interface, customers – some of a very young age – are given the possibility to co-design products as various as the toothbrush holder or the self-lacing sneakers.

Within the industries, most firms envision that such smart, connected objects are likely to be very popular (Ernest-Jones, 2008). Notably, with the proliferation of mobile phones, tablets and the increasing number of connected objects, they argue it is likely to be implemented at low

cost (Ernest-Jones, 2008). Beyond it, firms are highly interested by smart customization, as it should permit the collection of user data at the usage stage of the purchased product, which is highly valuable (Rangaswamy & Pal, 2003). For one thing, it enables them to retrieve upcoming market trends related ideas and needs related information from their customers that, for instance, could permit to enhance their new products. Notwithstanding the importance of research from the firm's perspective, the one from the customer's side is also important when considering customization activities with UTCDC (Ihl, 2009).

Customer's Perspective on Customization Offers

Following the definition of Piller (2005), customization via UTCDC refers to a customer co-design process, which meets the needs of each individual concerning certain features of their products. Thus, it appears evident that firms need to gain relevant information on the customer's predispositions for UTCDC as they are not only customers but also highly involved in the customization activities (Ihl, 2009). Presently, a growing stream of research exists in the field of marketing and consumer behaviour that addresses this research aspect (see, e.g., Dellaert & Dabholkar, 2009; Piller et al., 2010). In particular, various angles have been used to understand better UTCDC from the customer's point of view, meaning, from the technology acceptance to the customer's decision-making process (Ihl, 2009). In what follow, are a short summary of the research that serves as a solid groundwork for my studies on smart customization.

First, about the UTCDC' technology acceptance, research shows it permits to enhance the customer acceptance for customization offers (see, e.g., Dellaert & Stremersch, 2005). That is, previous research reveals the evidence for two different dimensions of UTCDC' nature that influence the customer acceptance, that is, either the utilitarian one i.e. the expectation of having a product with a closer preference fit or the hedonic nature i.e. the intention of having a fun experience in the co-design activities (e.g., Addis & Holbrook, 2001; Hirschman & Holbrook, 1982). Notably, Addis & Holbrook (2001) posit that the hedonic part is likely to acquire some importance due to the experiential nature of co-design in such customization offers. Additionally, in a more recent and complementary research, Dellaert & Stremersch (2005) uncover that the perception of complexity is a barrier to the UTCDC' adoption. That is, the

authors unveil in the empirical study the negative impact of perceived complexity on the customer's satisfaction on the mass customization process and the customized product customer created. Furthermore, Guilabert (2005) so as Piller et al. (2010) and Thompson, Hamilton & Rust (2005) mention two other key determinants i.e. feature fatigue and perceived product customization that prove to be relevant in the customer acceptance of UTCD. In this regard, they define "perceived product customization" as representing customers who have already a customized product prior to the use of UTCD, while feature fatigue refers to some customers who feel defeated by the number of features they have to handle in the product they own. Both revealed their influences in the following way on the customer acceptance: feature fatigue with a negative impact, while perceived product customization with a positive one.

Second, one aspect that research started to address is the importance of understanding how customers prefer a design of a customization offer in comparison with another (e.g., Dellaert & Dabholkar, 2009; Ihl, 2009). The aim is, of course, to provide firms with some insights into how individuals choose these offers. In this stream of literature, I noticed three design features, which prove to be relevant in the customer's choice process for a customization offer. There are: the number of adaptable features, visualization so as the help functions. The three were extracted from a variety of discussion on mass customization offers (see, e.g., Dellaert & Dabholkar, 2009; Lurie & Mason, 2007; Randall et al., 2005). First, Dellaert & Dabholkar (2009) show in their empirical study that help functions enhance the perceived benefits of mass customization offers, whereas they decrease the perceived complexity. Additionally, Simonson (2005) uncovers that it is likely to differ whether customers have preference variability or preference insight. Second, according to Botti & Iyengar (2006) and Schwartz (2004), customers are likely to select a product with a higher number of choices, as, for them, the more, the happier they are, but, on the other hand, are not able to deal with the bunch of features during the usage stage of their product. Third, about visualization, it seems that some high visual aspects are selected by all customers, due to their influence on the hedonic value of UTCD (see, e.g., Hirschman & Holbrook, 1982; Holbrook & Hirschman, 1982; Holt, 1995). Finally, as the issue of intrusion is growing in importance, it has become a factor of importance in the choice process of customers (see, e.g., Caudill & Murphy, 2000; Martin, Borah &

Palmatier, 2017; Milne, 2000). For the moment, what is certain is that customers do not want in their product, their personal data to be taken without their full awareness (Milne, 2000).

Co-Creation and Design Theory

Today, co-creation is meant to denote an act of producers-customers interaction in which customers have an active role in the development of a product in a process made available by firms (see, e.g., Prahalad & Ramaswamy, 2004; Udwadia & Kumar, 1991; Wikstroem, 1996). Udwadia & Kumar (1991) were the first one to come up with this notion that customers and firms could become co-designers of those products that could respond to each customer's individual use. Later on, as mentioned earlier, von Hippel (2001) and von Hippel & Katz (2002) applied the notion by equipping customers with some UTCD. Since then, the principal focus of the research has been on the development of UTCD and the environment related to the fabrication of the customized products (Franke & Piller, 2003; Thomke, 2016). Yet, in the view of certain researchers from the field of co-creation, this research is not enough as the co-creation can uniquely occur if customers take an active part in the co-design process. As a start, they should have at least a blurred idea of what they want (see, e.g., Udwadia & Kumar, 1991; Wikstroem, 1996) and reflecting the reality on customization offers, it, is not yet the case. Although it reveals not to be a problem with low-end toolkits, it is particularly true for high-end toolkits (Jeppesen, 2005). A majority of customers do not feel capable of dealing with them (Franke & von Hippel, 2003). For instance, Franke & von Hippel (2003) illustrate it with the case of the Apache Software – a smart high-end toolkit –, where they uncover that only 37% of the interviewed customers felt they could create what they want, the rest just sensed they could uniquely reuse what others created. Certainly, it has to do with the fact that the interaction patterns of UTCD with customers that permit them to obtain their ideal solutions remain unclear, the issue being addressed already in 2003 by Franke & Piller. Yet, as mentioned by these authors, it could be only solved, once one comprehends further the co-design mechanisms involved in the customer – (smart) UTCD interaction.

To do so, it is essential to integrate another field of research, which is, the design theory and methods for innovation, that includes, notably, the C-K theory (Hatchuel & Weil, 2003; 2009).

By making use of these theories, Brown (2013) developed the theoretical framework for use generation, which can be used here to uncover the interaction patterns of UTCD. It should, indeed, permit to expose the reasoning of the design of uses i.e. create a solution or design for a specific use necessary to obtain the patterns. In this regard, the framework consists of the development of a canonical model called “product-use” ($x, D(x), P(x), K(x)$) (Brown, 2013). Figure I.2. shows one application of this framework with the shared city bike system “Velib” and the unique use created by users.

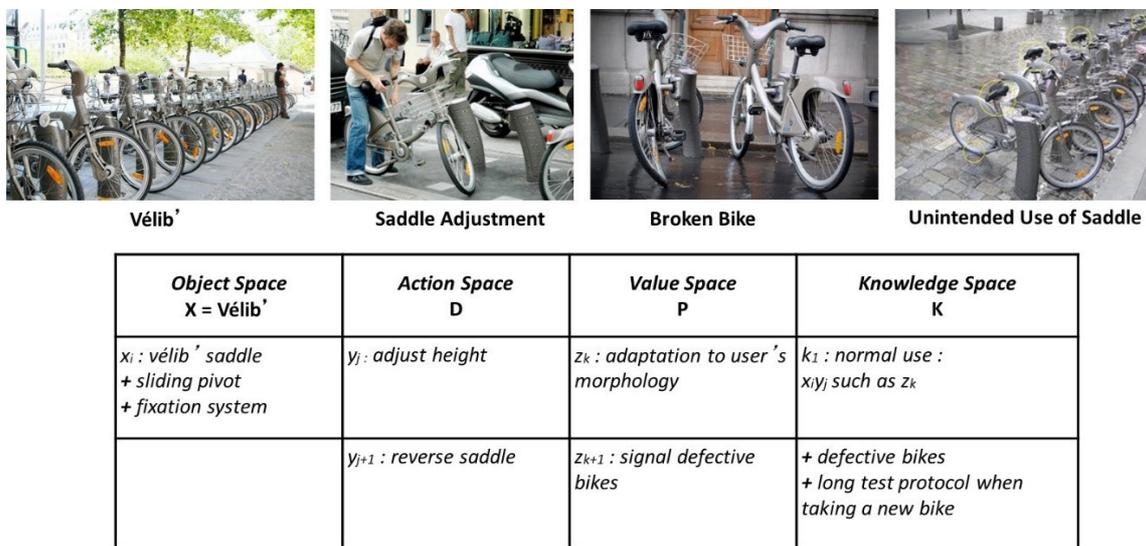


Figure I.2. Illustration of the Canonical Model of Product-Use with the Velib
Source: In a Power Point Presentation of Brown from 2013

Hence, with the framework, it permits to express the design reasoning as a logic of the interaction processes between the user’s knowledge on smart UTCD and the smart UTCD’ design possibilities which organizes the “co-creation” of solutions known (i.e. with low-end toolkits) and unknown by users (i.e. with high-end ones) for the customer’s individual uses. It is called “canonical model of product-use” by Brown (2013) as the underlying idea is to have a formal distinction between x which is the design space of UTCD (i.e. for the Velib, the saddle and its fixation system), $D(x)$, the space of actions supported by UTCD (i.e. for the Velib, adjust or reverse the saddle), $P(x)$ the space of values associated with UTCD (i.e. for the Velib, to adapt the seat to the user’s morphology or to signal the bike is broken) and $K(x)$, the user’s knowledge space (i.e. knowledge on how to manipulate the saddle). Accordingly, this

theoretical framework can model a co-design process as an interrelated enlargement of the three spaces i.e. $D(x)$, $P(x)$, $K(x)$ on x . In other words, the D space can describe the gradual understanding of smart UTCD' possible actions by users, P the progressive generation of values (i.e. creative ideas) and K the increase of knowledge of users in the given product domain, all via the effective learning process.

Summary of the Articles

The second part of this dissertation includes three independent, but thematically linked articles that tackle the questions identified in the previous section. For every article, the tables below (Table I.1., Table I.2., and Table I.3.) provide an overview of the state of the art, the key research questions, the selected methodology, the main results so as the final contributions.

Article I: Smart Customization a Realistic Alternative to Mass Customization?

In the future, smart customization is likely to be largely widespread. Currently, more and more producers tackle the challenge of equipping their consumer products with some smart UTCD to turn them into customizable ones (Ernest-Jones, 2008). One of the benefits compare to others is likely to lie in their singular capabilities – notably, via the effective learning effect – to respond better and faster to the customers’ individual needs. Yet, surprisingly, the marketing and consumer behavior literature on customization that addresses this topic is scarce (Piller et al., 2010). Thus, as a first step in this research, it is essential to understand the customer acceptance and uncover the contingent factors. Of course, prior research on the UTCD acceptance is of use (see, e.g., Fiore et al., 2005; Guilabert, 2005; Piller et al., 2010). They already identified certain determinants such as the customer’s perceptions on UTCD (i.e. perceived usefulness, perceived enjoyment, perceived complexity of use) and on the product they own (i.e. perceived product customization, feature fatigue) that could potentially influence the smart UTCD acceptance. Moreover, recent research in consumer behavior shows how critical is the impact of two personal traits of consumers (i.e. preference insight, preference variability) on their responses on customization offers (see, e.g., Bharadwaj et al., 2009; Simonson, 2005). Accordingly, making use of both streams of research, the purpose of this article is to contribute to theory and practice by studying the effects of the above-mentioned factors on the smart UTCD acceptance. Additionally, it aims at demonstrating that smart customization is not only on theory a valuable but, also a realistic alternative to consider over mass customization.

To fill this gap, I developed a technology acceptance model. My theoretical model links the customer’s perceptions on smart UTCD (i.e. perceived usefulness, perceived complexity of use

and perceived enjoyment), the customer's point of view on the product they own (i.e. feature fatigue and perceived product customization) to the smart UTCD acceptance. Furthermore, I added to the model, the two factors linked to the customization related consumers' personal traits i.e. preference insight and preference variability. It permits me to shed light on the characteristics of customers who intend to use smart UTCD so as how both affect the model. I tested my model and its hypotheses with two samples of respondents, respectively one from the car industry i.e. 263 respondents and one more reliable from the mobile industry i.e. 250 panelists, on two empirical settings of smart UTCD - both being apps either for mobile phones or cars - that assist customers to co-design the features of their product. Altogether, my results supported my hypotheses except the ones related to feature fatigue. In greater details, alike the findings in the mass customization literature (e.g., Dellaert & Stremersch, 2005; Fiore et al., 2005), smart UTCD acceptance is positively explained by, first, perceived usefulness, second, perceived enjoyment, and then, negatively by perceived complexity of use. Moreover, my findings unveiled, so as predicted, that the personal traits of customers affect the model. Most importantly, they supported the hypotheses that mainly customers who do not have well-defined preferences (i.e. preference variability) are willing to use smart UTCD, next to a sub-group of customers with preference insight who possess already a customized product.

This article offers at least three primary contributions. First, it contributes to the development of some theoretical and empirical foundations on smart customization by introducing further the concept and by adding to our insufficient knowledge on the customer acceptance and its contingent factors. Second, it extends previous research on customization offers in the field of marketing and consumer behaviour by providing empirical evidence from the customer's perspective on smart customization offers and by comparing the results with the ones on mass customization (see, e.g., Dellaert & Stremersch, 2005; Fiore et al., 2005). Finally, it also strengthens the relevance of various studies on customization that highlight the importance of the hedonic nature of customization offers (see, e.g., Franke & Schreier, 2010; Schreier, 2006). My findings reveal, notably, that it is a critical determinant for the acceptance of customers with preference variability.

Table I.1. Summary of Article I

<i>Article I</i>	<i>Smart Customization a Realistic Alternative to Mass Customization?</i>
What is known	Smart customization is likely be a complementary alternative to mass customization.
What is not known	There is merely research on the customer's perspective on smart customization offers, notably, on the customer acceptance.
Research objective	Examination of the customer acceptance of the key elements of smart customization i.e. smart UTCD and the contingent factors
Theoretical framework	<ul style="list-style-type: none">• Technology acceptance model• Marketing and consumer behaviour research on mass customization
Sample	<ul style="list-style-type: none">• 263 American car owners. They are extracted from miscellaneous mailing lists of car owners' associations.• 250 American respondents who have a smart phone. The sample is elaborated by an online research firm from a pool of android phone users in return for financial incentives.
Empirical settings	<ul style="list-style-type: none">• Tasker, a smart UTCD (an app) that assists customers to customize the features of their phones.• A smart UTCD like the Tasker but for cars (an app) that guides customers to customize the functionalities of their car.
Methodological approach	<ul style="list-style-type: none">• Quantitative• Partial Least Squares (a reason is the exploratory nature of the study).
Major results	Smart UTCD acceptance is explained by the customer's perceptions on these artefacts i.e. perceived enjoyment and usefulness and depends on the customer's personal traits.
Key findings	Smart UTCD are mainly accepted for hedonic and utilitarian reasons. Additionally, customers with preference variability are the target customers.

Managerial implications A major implication is that producers should focus on improving the hedonic nature of smart UTCD for the customer acceptance.

Article II: Conceptualizing Smart User Toolkits for Co-design in Accordance with Customer Preferences

Marketing research in mass customization started to show lately the importance of examining to which extent customers prefer a customization offer (see, e.g., Dellaert & Dabholkar, 2009; Randall et al., 2005). In this article, following this trajectory, I intend to shed light on what attracts customers in the smart UTCD' design features (i.e. the number of adaptable features, visualization, help functions, intrusion). To date, literature focuses principally on the role of the above-listed features in the smart UTCD' functional aspects (see, e.g., Tseng & Piller, 2003; von Hippel & Katz, 2002) but there is barely research on how they influence the customer decision-making process for smart UTCD (Gross & Antons, 2009). This is, notably, why there is often one standard offer proposed in customization. Yet, as stated by Randall et al. (2005), it is surprising, given that customization is developed on the idea that customers' preferences are heterogeneous in the selection process of products. Further, focusing on smart UTCD, the additional challenge is to find the key features that increase their desirability while preserving the functional aspects for the target customers. It is proper to smart customization offers, as they are consumer products. Therefore, an adequate smart UTCD should be effective and attractive.

That said, I address this critical research gap by building on the consumer choice theory (McFadden, 1986), the previous marketing research on mass customization (e.g., Dellaert & Dabholkar, 2009; Ihl, 2009) and the traditional literature on UTCD (von Hippel, 2001; von Hippel & Katz, 2002). My central premise is that the utility of a smart UTCD is affected by their design features (i.e. visualization, the number of adaptable features and help functions), the more traditional ones (i.e. intrusion, price) and the personal traits of customers (i.e. preference variability, preference insight). As a reminder, price is used as a control variable so as often realised in these studies (e.g., Dellaert & Dabholkar, 2009). To test the developed theory, I realized a choice based conjoint analysis on the Tasker (i.e. an app that empowers

users to customize the features already present). My analysis of a data sample of 250 mobile phone owners supported all my hypotheses. Shortly, my results showed that visualization and help functions, after intrusion, affect significantly the smart UTCD' utility. Regarding the number of adaptable features, unexpectedly, it does not play a major role in the consumer preference structure, which is a positive point for producers i.e. paradox of choices. Moreover, I found, so as predicted, that customers in function of their personal traits prefer to select visualization and help functions in the way that both factors should serve them the best in the customization process.

Overall, this article contributes to the literature in three ways at least. First, it extends prior research that focuses on the importance of understanding the customer's point of view on customization offers by shedding light on the importance of having specific design features within smart UTCD for the targeted customers. Second, it adds to the traditional literature on (smart) UTCD by conceptualizing them further in accordance with customer preferences. Finally, It enrich our knowledge on new data and new processes by confirming the importance of an "adaptive solution space" from the customer's side (Rangaswamy & Pal, 2003) and by , in the same time, stressing the fact that customers definitely do not want intrusive systems.

Table I.2. Summary of Article II

<i>Article II</i>	<i>Conceptualizing Smart User Toolkits for Co-design in Accordance with Customer Preferences</i>
What is known	Customization offers are always standards. Research in consumer behavior and marketing emphasizes the importance of understanding how customers select customization offers.
What is not known	Little is known on the customer's decision-making process on the key elements of smart customization offers i.e. smart UTCD and especially according to the design features.
Research objective	Investigating the customer preference structure for smart UTCD' design features
Theoretical framework	<ul style="list-style-type: none">• Choice based theory of Mc Fadden (1986)• Marketing and consumer behaviour research in the context of mass customization offers
Sample	<ul style="list-style-type: none">• 250 American respondents that own a smart phone. The sample is elaborated by an online research firm from a pool of android phone users in return for financial incentives.
Empirical setting	<ul style="list-style-type: none">• Tasker (a smart UTCD for mobile phones)
Major results	Customers prefer smart UTCD that integrate help functions and with a high visual aspects. The preferences concerning the smart UTCD' design features vary in function of the target customers.
Key findings	Customers select help functions and some visual aspects in the way to assist them to maximize the value of customization.
Managerial implications	Some ingenious design tactics of smart customization offers are provided that suit the target customers.

Article III: Interaction Patterns of Smart User Toolkits for Co-design with Customers for an Ultimate Solution

UTCD are means that permit to apply the notion of co-creation (von Hippel, 2001). That is, with these systems, firms and customers can be co-designers of those products fitting the customer's exact needs (Udwadia & Kumar, 1991). Notably, it is used in the customization strategies so that firms can propose products with closer preference fits at lower costs (e.g., Pine, 1993). In this research, however, the focus has always been on the technical aspects of UTCD and the production environment that goes along with it, but, an important research topic is the interaction patterns of UTCD to co-design with customers their ideal solutions (Franke & Piller, 2003). Even though there are a few publications of interest on how to support customers to co-design with UTCD (Jeppesen, 2005; Lakhani & von Hippel, 2003), it remains clearly neglected because of the lack of understanding of the co-design mechanisms that occur between users and UTCD (Franke & Piller, 2003). Yet, it is crucial for firms to comprehend it further, as customization can only take place with the customer's deep involvement in the co-design activities with UTCD (Udwadia & Kumar, 1991; Wikstroem, 1996). Without it, reality shows us that customers fail to customize (Franke & von Hippel, 2003). Thereby, the aim of this paper is to attempt to fulfil this long-term research gap. That is, I seek to examine the co-design mechanisms involved in the customer – smart UTCD interaction, identify the nature of these mechanisms so as pinpoint the difficulties that occur. Additionally, I seek to propose additional services, under which these mechanisms are more effective.

For this purpose, I made use, as a first time in this field of research, of the theoretical framework for use generation realised by Brown (2013). This permits me to expose the co-design mechanisms that occur between customers and smart UTCD in the customization activities. Then, I applied the framework on two types of smart UTCD that exist i.e. high-end and low-end toolkits (Prügl & Schreier, 2006). As a high-end toolkit, I used the Lego Mindstorms and as a low end one, the Adidas One. Resulting from it, I uncovered, by making use of the C-K theory - which permits to make a clear separation between the spaces of concept i.e. C and the spaces of knowledge i.e. K in the design process (Hatchuel & Weil, 2003; 2009) - the nature of the co-design mechanisms. I showed that high-end toolkits are disjunctive and low-end ones

conjunctive. Briefly, it means that the high-end smart UTCD provide the unusual capabilities to empower users to develop unknown solutions, while low-end ones deliberately guide and restrict users towards an existing solution. In so doing, it permitted me to pinpoint the known difficulties that occur (i.e. when they are conjunctive or disjunctive) and so propose accordingly measures that permit to overcome the issues and increase the effectiveness of the co-design between customer and smart UTCD. That is, my results, notably, revealed that high-end smart UTCD are just “uninspiring” for most customers, meaning, they have no vague ideas of what to create. In this regard, a measure is to propose some tutorials of a few creations along with smart UTCD, which proved to enhance the creativity of users (Agogu , Poirel, Houde, Pineau & Cassotti, 2014). Up till now, firms do not propose them with most high-end smart UTCD, an exception is the Lego Mindstorms, which confirms the effectiveness of the measure. Indeed, users – sometimes of very young age such as 12 years old – after creating the tutorials at their disposals are entirely able to create their own solutions. About the low-end smart UTCD, the study confirmed that instruction manuals (i.e. for every conjunctive products) are necessary to balance the potential lack of technical skills of their customers.

Altogether, the contribution of this paper is in threefold at least. Primarily, it adds to the literature on customer co-creation in the context of customization by opening the black box on the co-design mechanisms that occur between customers and smart UTCD. Second, it also, extends literature that focuses on support and supervision of customers when interacting with UTCD by finally uncovering all difficulties that occur from the customer’s side and by identifying better-suited support for smart UTCD (i.e. interaction patterns). Finally, its contributes to a broader literature on co-creation with a lay person by showing how the use of the modern design theories helps to expose the co-design mechanisms and propose suitable solutions (i.e. it can be employed to understand the co-design mechanisms that are involved between a lay person and UTCD in 3D printers).

Table I.3. Summary of Article III

<i>Article III</i>	<i>Article III – Interaction Patterns of Smart User Toolkits for Co-design with Customers for an Ultimate Solution</i>
What is known	Smart UTCDD rely on the notion of customer co-creation. Certain Smart UTCDD fail to involve customers in the customization activities.
What is not known	There is hardly research that addresses the topic of the interaction patterns of smart UTCDD.
Research objective	Identification of the interaction patterns of smart UTCDD to permit to the mass to co-design their ideal solution.
Theoretical framework	<ul style="list-style-type: none">• Theoretical framework for use generation• C-K theory• Customer Co-creation & Customization
Major results	Low-end toolkits are conjunctive, high-end toolkits are disjunctive.
Key finding	While the issue with high-end toolkits is that, for most customers, they are just “uninspiring”, in contrast, with low-end toolkits, users may find it hard to employ them rightly.
Managerial implications	With high-end toolkits, some tutorials of a few creations are essential prior to their uses, whereas with low-end toolkits, instruction manuals are the solution to use them properly.

General Discussion and Conclusion

The purpose of this dissertation is to add to the literature on customization offers by introducing a new approach of customization i.e. smart customization and by investigating the customer's perspective on the key elements of this approach i.e. smart UTCD. In this setting, after demonstrating that smart customization is of high value, it, first, aims, as an initial step in this research, at examining the customer acceptance and uncovering its contingent factors. Second, influenced by the research on the consumer behaviour and marketing in mass customization offers (see, e.g., Dabholkar & Bagozzi, 2002; Dellaert & Dabholkar, 2009; Ihl, 2009), it looks at the customer's preference structure on smart UTCD's design features. Finally, it aims at understanding the co-design processes that occur between users and smart UTCD in the creation of an optimal solution, and, in turn, providing the interaction patterns of smart UTCD. Altogether, the three studies permit to give in depth knowledge on the customer's perspective on smart customization offers. In details, it is from the customer acceptance to his involvement in the co-design activities by means of smart UTCD. Thereby, it contributes to a more holistic view on such new customization approach. To reach these goals, in my three articles, I use three extremely different studies and methods. As such, in Article I, I adapted a technology acceptance model to smart UTCD and did a structural equation modelling via PLS. As for article II, I developed a conceptual framework purposely built with the discrete choice and latent variables approach used in the marketing literature and suggested by McFadden (1986), Ben-Akiva & Boccara (1995), Ashok, Dillon & Yuan (2002) and Ihl (2009). Then I realised a choice based conjoint analysis to examine the respondents' preference structure for smart UTCD. In article III, I exposed a theoretical framework of use generation (Brown, 2013), which permits me to examine the mechanisms of co-design with smart UTCD. Besides, with regard to Article I and II, it is worth mentioning that I do not use conveniently a sample of students as it is often the case in research (Franke et al., 2009) but instead a sample made out of respondents that are representative of the American population. The latest certainly adds to the reliability and validity of my studies.

About the findings of my dissertation, my first article reveals that the customer acceptance is principally influenced by the perceptions they have on smart UTCD, which surprisingly is not

only perceived usefulness, the main determinants being perceived usefulness and perceived enjoyment. Fortunately, perceived complexity of use seems not to play a major role compare to the two others. Besides, it uncovers the characteristics of the customers willing to use the toolkits; those are the ones with preference variability and the ones with preference insight who possess already a customized product. In so doing, by investigating the user acceptance, Article I is a good starting point in my research on smart UTCD that looks at the customer's point of view. In the second article, my results show that there are important features to consider for the design of smart UTCD in order to succeed in the market place and that it depends significantly on the personal traits of customers i.e. preference variability and preference insight. Firms can then use these findings to develop smart UTCD according to the target customers. About Article III, it focuses on the customer's interaction with smart UTCD in the pace to co-design an ultimate design or solution. In this way, it uncovers that high-end toolkits are disjunctive and low-end ones conjunctive. Further, it reveals particularly that the co-design process with the high-end ones are extremely challenging for most customers because they have no clues on what to create with the tools. However, altogether, it permits to provide the interaction patterns of smart UTCD in customization.

Theoretical Contribution

The results of my dissertation contribute to the literature on new product development, user toolkits for co-design, consumer behaviour and marketing in the context of customization offers, customer co-creation and smart, connected products.

First, this dissertation, influenced by the papers of Gross & Antons (2009), Hermans (2014), and more recently Thomke (2016) introduces and provides in-depth knowledge on a novel customization approach based on the recent applications of ICT in our consumer products. The notion is to empower a layperson to customize – to a more or less extent – the products they own by equipping them with smart UTCD. To date, the academic research on customization – mostly restricted to mass customization – clearly falls behind the reality, suggesting a large shortcoming in transferring practice into research (Thomke, 2016).

Second, referring to the marketing research in the context of customization offers (see, e.g., Bharadwaj et al., 2009; Frank & Hader, 2014; Simonson, 2005), this dissertation studies two factors linked to the personal traits of consumers (i.e. preference insight and preference variability) that were previously used on their responses to mass customization offers, on smart UTCD. Prior research shows us that mass customization offers are not perfectly suited for customers who do not have stable, well-defined preferences (Bharadwaj et al., 2009; Simonson, 2005; von Hippel & Katz, 2002). In this dissertation, I contribute to this literature by showing, based on the above articles and my empirical evidence, that (1) smart UTCD are particularly adapted for customers with preference variability so as (2) the acceptance of smart UTCD by these customers. First, I argue, fuelled by the recent findings of Franke & Hader (2014), that smart UTCD fit perfectly customers with preference variability because of their effective learning effects. Then, my findings show, besides confirming that customization appeals to most customers, that customers with preference variability intend to employ smart UTCD. Beyond it, my results unveil that they are less price sensitive than the other customers, which indicate they attribute a high value to smart UTCD.

Third, this dissertation enriches our limited understanding of the contingent factors that influence the smart UTCD' customer acceptance (Piller et al., 2010). I argue that it depends on the customer's perceptions on smart UTCD and on the product they own so as their personal traits as consumers of customization offers. My findings underline it by showing that these factors – except for feature fatigue – are clearly associated with the smart UTCD acceptance. Thereby, for whom, which product domain and which smart UTCD' dominant design nature (known to influence the customer's perceptions) matter for the customer acceptance. Further, I also contribute to this literature by uncovering that there is a customer request for smart UTCD (i.e. due to the reliability of my sample).

Fourth, I confirm prior results of a few empirical studies, which show that the hedonic nature, known to evoke the fun aspect of UTCD, is essential in the customization offers (see, e.g., Fiore et al, 2005; Franke & Schreier, 2010; Schreier, 2006). In this dissertation, my findings reveal that the fun aspect (i.e. via perceived enjoyment of smart UTCD) is one of the two critical factors – first or second depending on the customer's personal traits – that affects the smart

UTCD acceptance. Most importantly, my results identify that the hedonic value of smart UTCD is the key determinant of acceptance for customers with preference variability. An explanation taken from the literature is that such customers, because of their poor knowledge into what they want, are simply unable to select a product differently (Babin, Darden & Griffin, 1994).

Fifth, the dissertation complements the body of research that stresses the importance of examining the customer's choice process for a customization offer (see. e.g., Dabholkar & Bagozzi, 2002; Dellaert & Dabholkar, 2009; Ihl, 2009). As posit by Randall et al. (2005), it is somehow confusing that whereas customization is based on the evidence that consumers have heterogeneous needs and so are likely to attach value to different products, most customization offers remain standardized. In particular, it does not make much of a sense for customization offers with smart UTCD as they are consumer products, thus, selected by customers themselves. In this dissertation, after examining to which extent customers prefer one smart UTCD to another, my findings reveal two key features (i.e. help function and visualization) that are the most important for all customers and which vary in function of their personal traits. My results suggest, notably, that both are surprisingly selected in the way to assist each of them to maximize the value of customization. That is, while customers with preference variability select smart UTCD with all help functions available and a high degree of visualization, given they are likely to not have the right "innovative design" skills (Simonson, 2005), in contrast, customers with preference insight, known to be experts in a selected product domain (Hoeffler & Ariely, 1999), tend to select no help functions (as of no use for them) and no visual aspects, because it may hide important information from them (Lurie & Mason, 2007). Hence, with these findings, I contribute to the above marketing literature by confirming that carefully selecting certain design features in a customization offer for a target customer is of high relevance. Additionally, my results permit to support the claim of Randall et al. (2005), which is to propose rather "graded toolkits" than standard ones.

Sixth, related to the previous point, the dissertation strengthens the relevance of the literature focused on the design features related to the function aspects of UTCD, which are currently said to not always be applied by firms (Franke, Schreier & Kaiser, 2010; Piller & Salvador, 2016). In this literature, a great deal of evidence shows that visualization and help functions are

essential (see, e.g., Franke & Hader, 2014; Jeppesen, 2005; von Hippel & Katz, 2002). Concerning the development of the solution space, it is reported that producers should be the ones to decide on which product's features can be customized and to what extent (see, e.g., Piller, 2012). Such results are in line with the findings of my dissertation that look at the same design aspects of smart UTCD, but, from the customer's perspective. In details, my study reveals that the two most important features for customers are help functions and a high degree of visualization and that, customers, do not attach importance to the number of adaptable features in smart UTCD. The latter would have been an issue, as all customers tend to select the highest number of options in products - so as also shown in my findings - but are, in fact, unable to deal with them (Botti & Iyengar, 2006; Schwartz, 2004). Therefore, my findings suggest, so as seen in the literature on the concept of UTCD (von Hippel, 2001; von Hippel & Katz, 2002), to let firms decide by themselves on the number of adaptable features to include in the UTCD.

Seventh, my dissertation, additionally, contributes to the recent research on new data, new skills, and new processes, listed as one of the top research priorities of 2016 -2018 by the Marketing Science institute (2016). First, I propose and add to such promising research a new process to collect user data by equipping consumer products with some smart UTCD. The latter have the singular ability to retrieve valuable information on users in the co-design of their product. Second, in this regard, my findings show further that it can be worth having this process to help customers to obtain their ideal solution by collecting information on their personal traits, so as their preferences or needs on the product they own. Notably, as suggested by Tseng & Piller (2003) or more recently Wang & Tseng (2014), it would permit firms to provide an adaptive solution space for each customer over the life cycle of their product. Furthermore, my results show that there is a limit to retrieve data from users. They indeed reveal that the intrusion factor has a significant negative impact on the preference structure of customers. In fact, it is the most important factor in the decision-making process of customers for smart UTCD. In this way, I could contribute further to this research by revealing a new process in which firms have to strike a delicate balance between retrieving valuable data, used

for instance, for an adaptive solution space and by collecting information viewed as privileged by their customers.

Eight, I complement literature on customer co-creation by opening the black box on the co-design mechanisms that are involved within the customer and the smart UTCD. Franke & Piller (2003) show there is hardly research on it and subsequently the interaction patterns of smart UTCD remain fuzzy. In this dissertation, I fulfil this long-term research gap by making use of another stream of research, which is the design theory and methods for innovation, notably, by employing the theoretical framework for use generation of Brown (2013). The latter finally enables to expose the co-design mechanisms that occur between customer-smart UTCD. In so doing, I could uncover that high-end smart UTCD, being disjunctive in nature, provide the right settings to co-design unknown solutions, but too frequently fail to give customers a sense of a possible solution, while low-end smart UTCD, being conjunctive in nature, permit customers to have a blurred idea of what could be their solutions but may be unsuccessful to give them the right technical instructions. Following these findings, based on the seminal work of Agogu e et al. (2014) on the fixation effect, it permits to suggest interaction patterns of smart UTCD for customization, that is, regarding high-end smart UTCD, to propose tutorials of a few creations, whereas, about low-end toolkits, instructions manuals.

Ninth and related to the previous contributions, I identify tutorials of a few creations as a novel measure to support customers with high-end smart UTCD in their customization activities. In particular, my results add to the literature on the support and supervision by uncovering that it is not enough to provide only technical assistance to customers (Franke & Shah, 2003; Jeppesen, 2005; Lakhani & von Hippel, 2003). My findings, notably, reveal that it is needed to support customers to enhance their creativity (or more generally “innovative design skills). So far, in the associated literature, it was revealed that, whereas it is feasible to equip customers with high-end smart UTCD, it is unlikely they possess the adequate “design” skills to undertake such uneasy design tasks. Further, in the same line of research, it is suggested to overcome this issue by adding services such as user communities or user – to user assistance established to assist technically less skilled users in their pace of co-designing their creations (see, e.g., Franke & Shah, 2003; Jeppesen, 2005). Yet, my findings show that the issue is less about the

customer's lack of technical skills but rather because, for most customers, high-end toolkits are just uninspiring i.e. they have no clue on what to create with these design tools. In this matter, tutorials of a few creations are a solution (Agogué et al., 2014). A good illustration is the Lego Mindstorms, which succeeded to transform laypersons into "creator-designers".

Finally, my dissertation opens up a promising and stimulating research avenues on the smartness, adaptability and connectivity our consumer products are currently turning into. It does so by providing some theoretical foundations on these novel objects and empirical evidence from the customer's perspective on their readiness for this novel technology. So far, research that has addressed this topic is in the field of ergonomics and industrial design; in contrast, there is hardly research in innovation management (Rijsdijk, 2003; Rijsdijk & Hultink, 2009). Besides, the focus has always been on the first generation of smart products such as Sony AIBO, Eletrolux Vaccum Cleaner, etc. Ever since, smart products tend to be rather oriented towards some cyber/physical systems with which one can create novel features via connectivity (Bechtold et al., 2014).

Overall, the three articles provide a better and more thorough understanding of smart UTCD by looking at the customer's perspective. Through the three studies, I contribute to creating a more holistic picture of these modern design toolkits.

Managerial Implication

The theoretical contributions and results mentioned above lead to important implications for firms striving to simultaneously tap the opportunity of developing such customized offers while minimizing the risks to fail on the market. Explicitly, this dissertation provides valuable measures to producers to identify and adapt smart customization offers for the target customers.

First, results of my dissertation identify smart customization offers as a valuable and realistic customization offers. First, the main argument, based on theoretical foundations, is that smart customization is likely to be better suited, as customer needs are shaped over years in a given product domain (see, e.g., Bettman et al., 1998; Fischhoff, 1991; Slovic, 1995), for most customers who do not have well-defined, stable preferences. Second, my findings indicate that

there is a rather large acceptance of smart UTCD among customers, which can be interpreted as a customer request, given that the sample of respondents is highly reliable. Beyond it, my results suggest that some of the consumers, i.e. the ones with preference variability, are likely to pay a premium for such offers. Thereby, the results encourage producers to propose smart customization offers. If successful (i.e. customer customizes a product with a closer preference fit), producers are likely to be finally rewarded with a higher customer loyalty, which in turn should generate, as posited by Pine et al. (1995, p. 177) an “insurmountable barrier to competition, for one individual customer at a time”.

Second, producers that are concerned about the smart UTCD acceptance from customers need to understand the role of the design nature of smart UTCD. My results suggest that proposing smart UTCD with a rather hedonic nature where the design objective is the fun aspect and prolong the use trigger the customer acceptance. Notably, my findings identify the fun aspect as the principal factor that explains the acceptance of the most important customers characterized as having preference variability. Thereby, I suggest, producers, as individuals look for the fun part via several sensory ways in their products (Holbrook & Hirschman, 1982), to exploit these findings by including hedonic content in smart UTCD such as animated images, sounds and aesthetically attractive outputs.

Third, my results uncover the critical role that plays the perceived complexity of use in the smart UTCD acceptance. My findings show that even though it has a minor role, it still has a negative effect that can affect the acceptance. Notably, due to the fact that smart UTCD are made of ICT components, some scholars posit that perceived complexity of use has to be considered greatly (e.g., Bauer & Mead, 1995; Norman, 1998; Rijdsdijk, 2006). That is, explicitly, products’ forms often give customers some hints on how to understand and categorize them (Bloch, 1995; Veryzer, 1995) but, with smart products, this relationship is often absent because the ICT elements do the work in the background (Rijdsdijk, 2006; Den Buurman, 1997). Therefore, from the customer’s perspective, these products can be seen as having a lack of affordance and viewed as complex (Bauer & Mead, 1995). To overcome it, I propose in the dissertation, so as strongly advocated by certain researchers in ergonomics, to consider a key

design aspect of smart UTCD, which is to have an adequate user interface (see, e.g., Den Burman, 1997; Feldman, 1995; Han, Yun, Kwahk & Hong, 2001).

Fourth, results of my dissertation identify certain features that permit firms to increase the desirability of smart UTCD on the market place. These features are help functions and visualization. They are explained in greater details in Article II. Furthermore, I do not only identify them but also provide producers with guidance on adapting these specific features in function of the target customer. In so doing, producers can select by themselves the right features for the diverse customers. Additionally, the results of my dissertation encourage firms to go beyond the traditional approach of customization offers, which is to develop rather standardized offers, by putting into effects the idea of a “graded toolkit” mentioned by Randall et al. (2005). The notion is to give the possibility to customers to adapt preselected design features of smart UTCD in order to have a better-suited design tools. That is, my findings reveal that individuals select both above features in the way that they will serve them greatly in the customization process. Thereby, my dissertation helps not only producers, but also customers, to have smart UTCD that permit them (i.e. with the right help functions and visual aspects) to maximize the value of customization.

Fifth, the results of my dissertation suggest a way to address finally the issue of the paradox of choice (i.e. customers select products with the maximum number of features, also shown by my findings, but are not able to deal with them at the usage stage), which is a real threat for producers, as smart UTCD are consumer products. In particular, it is important for firms to find a solution to have smart UTCD, which are attractive and effective for a better customer adoption and retention. Since I find help functions and visualization as the most important factors in the customer preferences structure, a solution for firms is to provide these both features in the smart UTCD’ design so that the number of adaptable features becomes negligible in comparison. This might sound trivial but as shown by Piller & Salvador (2016), it is not always applied by firms, even though advised in the traditional literature on UTCD (see, e.g., Randall et al., 2005; von Hippel & Katz, 2002).

Finally, additional services for smart UTCD in a form of support and supervision are crucial for a successful co-design with customers. Franke & von Hippel (2003) show it well with the

Apache Software, a high-end toolkit where only 37% of the interviewed users felt they had the right skills to co-create with the tool, the rest uniquely sensed to use the creations of the others. In this matter, my findings suggest that the current services proposed by most firms to support their customers in the co-design activities with UTCD are incomplete and fuzzy. My results, notably, indicate that, some services, for high-end toolkits, that permit customers to have the right “innovative” design skills are needed while for the low-end ones, some supports that enable customers to understand properly the usability of smart UTCD are essential. Moreover, I do not only identify what is missing, but I do provide producers with some measures in the form of additional services to support customers in the co-design activities. That is, I propose firms to offer along with high-end UTCD, some tutorials of a few creations like how Lego Mindstorms did it, while with low-end UTCD, I support the notion that instructions manuals are needed to help technically customers to find the right combinations.

Limitations and Directions for Future Research

The results of my dissertation can be uniquely considered when only looking at seven limitations, which constitute some opportunities for further research in this field.

First, my research needs to strive for generalization in light of two limitations, that are, the use of two American data samples and the collection of empirical evidence in two product domains i.e. cars and mobile phones. First, I used two data sample exclusively elaborated from a pool of American respondents. Thus, it can be deduced that they are some concerns regarding the generalizability of my findings to other cultural contexts. Indeed, the cross-national studies in marketing research frequently show differences, which are likely to affect my findings (e.g., Iyengar & Lepper, 1999). Thereby, I suggest for future research to reproduce the empirical studies in other countries to corroborate my findings. Second, I use data collected from two product domains with respondents owning either a car or a mobile phone. Yet, it is essential to collect data from other product domains to establish the broader validity of my findings.

Then, through ought my dissertation, I utilize the work of McFadden (1986) as a basis for my conceptual model. The author recommends combining discrete choice model and latent factor modelling to describe better the customer decision-making process for a product. My

framework is developed in accordance with this research and the previous marketing literature in the context of mass customization (Ashok et al., 2002; Ben-Akiva & Boccara, 1995). Explicitly, my model, inspired by the studies of Dellaert & Dabholkar (2009) on the product customization, incorporates latent variables related to the personal traits. Yet, even though, I describe further the decision-making process of customers, still, researchers, as suggested by McFadden (1986) have the possibility to investigate how certain features of customization systems are evaluated and mediated by more abstract latent factors of perceptions such as behavioural constructs before leading to the final customer preference structure.

Third, concerning how both empirical studies are conducted, a limitation must be notified to readers, that is, it is scenario based. Even though all efforts were realised to develop realistic manipulations of scenarios of smart UTCD' applications (see Appendix 1), panelists are likely to act differently in a real purchase situation (Guilabert, 2005). While it is current practices in research to use scenarios (e.g., Dabholkar, 1996), such shortcoming is an opportunity for further research. The idea is to reproduce both studies but with respondents having some tangible smart UTCD instead of being provided with scenarios. This method is closer to the reality because of the real test in use panelists can perform.

Fourth, in Article I, one must report that the technology acceptance study made use of two different data sets i.e. one of the two is extracted from a preliminary study realised by Piller et al. (2010). So, obviously, it would have been better for the reliability of this study to have used two reliable samples of respondents from the same online research company and collect data from the exact same (in wordings) online survey.

Fifth, Article III uses the theoretical framework for use generation (Brown, 2013) to understand better the co-design mechanisms carried out by smart UTCD. Based on this exposition, I suggest for high-end toolkits, a novel measure, that is, some tutorials of a few creations under which the co-design mechanisms are likely to be more effective. However, I should stress the fact that it is only theoretical based on the work of Agogu e et al. (2014) which focused on understanding better the fixation effect in creativity. Therefore, it can be viewed as a limitation in this article. It would be noteworthy for instance to conduct further research on it with a creative task in a field experiment so as realised by the authors of this paper.

Sixth, in Article III, I unveil that certain consumer products prior to the integration of smart UTCD have a very singular identity such as the Xbox, which somehow inspires some (lead) customers to generate disruptive uses (Brown, 2013). Often, firms propose to such customers with these “use generative goods”, some smart UTCD (i.e. it is the case with the Xbox, with the SDK 2.0, which is the smart UTCD integrated after the launch of the product). It is evident that in these specific contexts, the purpose of the smart UTCD is different. While smart UTCD introduce in the dissertation permit firms to exploit mature market with customization offers (i.e. Philips lighting control, Adidas One), the others aim at supporting “lead” or “experts” users in their efforts to co-design (von Hippel, 1986). Thereby, a suggestion for further research can be to reproduce the technology acceptance study with these unique products as empirical settings and compare the results. Yet, a modification needs to be realised which is to add some lead user characteristics in the TAM (Ihl, 2009) and remove the ones related to the customer preferences, which are no longer relevant.

Finally, my dissertation focuses on individuals that customize digitally their everyday products i.e. a differentiation through data elements and software rather than via tangible elements. For instance, the Tasker used as an empirical setting in Article I, II, assists users to combine and adapt the features present in their phones in order to create novel ones that suit them better. Although this customization approach is expected to be largely widespread due to the proliferation of smart phones and connected objects - i.e. intelligent house with the Philipps lighting control is a good archetype of it - it is in fact one method among several in the world of co-creation in tomorrow’s industry. Technology will more and more empower a layperson to co-design what they exactly want from closed systems i.e. Adidas One to extremely open, complex ones i.e. the Raspberry Pie (Brown, 2013; Ernest-Jones, 2008; Hermans, 2014). More than that, with the additive manufacturing, Obama (2016), for instance, posits that it has the potential to revolutionize the way we make almost everything. One can, for instance, think about integrating directly a UTCD into a 3D printer, which then would enable a layperson to create virtual custom design, which, unlike mass customization, can be immediately produced. A pioneering application is with Nike that proposes customizable football cleats of the shoes produced with additive manufacturing (Weller, Kleer & Piller, 2015). Thereby, this leads to

some ideas for further research related to the concept of UTCD originally developed by von Hippel in 2001 with the advent of internet and which is still described as “emerging” in the current research (Thomke, 2016). Figure I.3. shows an overview of the various customization offers of the sneakers.



Figure I.3. The Future of Customization?

Sources: adidas.com/us/customize; sneakersaddict.com; news.nike.com

Conclusion

Altogether, this dissertation aimed at closing the theoretical and empirical gap related to the customer's perspective on smart customization offers. That is, the three articles that compose the dissertation permit to have a better understanding on the (1) smart UTCD acceptance (2) the customer's choice process on smart UTCD so as (3) the co-design mechanisms that occur between customers-smart UTCD. In this way, my dissertation is a first step towards a more holistic view on the customer's point of view on smart customization offers so as, more generally, on the customer co-creation methods with UTCD. Beyond the theoretical implications, the dissertation offers many practical implications and measures that encourage producers to propose these novel customization offers by enabling them to increase such products' chance of success. Clearly, the dissertation provides them with some in depth-knowledge to design and target smart customization offers that fit better the target customers. Despite the theoretical and managerial implications, much remains to be understood, though, as it is just the beginning of some research avenues on the smartness, connectivity and adaptability of our consumer products (Ernest-Jones, 2008; Rijdsdijk, 2006). One thing is sure, customization is reinvigorating. Thereby, each of the three piece of papers that composes my dissertation also offers a rich agenda for future research in this field. Academics can address them to further deepen our knowledge on smart customization and improve our comprehension of the customer's perspective on such approach. Overall, the results of my dissertation contribute to the research on customer co-creation, customization, co-design activities with a lay person and, of course, smart products from the customer's perspective.

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Part II: The Three Articles that Compose My Dissertation

Article I – Smart Customization a Realistic Alternative to Mass-Customization?

Abstract. *To succeed in the market, consumer products must more than ever respond to the various needs of each individual. This is why producers constantly develop new approaches in the product development process. A popular one is mass customization. It is a mass production of a previously developed custom design realized virtually by a customer via a process made available by firms, where the main element is “user toolkits for co-design”. That said, the focus of this article is not on mass customization but on a recent approach that I call “smart customization” in this paper. It makes use of the progress in information and communication technology, which is increasingly becoming an integral part of our consumer products. In smart customization, user toolkits for co-design have become smart and tangible, which permit their direct integration into products. It has a great advantage in comparison with mass customization. The biggest advantage is that producers no longer have to retrieve the final custom design created by a customer so as manufacture and deliver it but instead empower customers to customize their products after purchase. Until now, research on “smart” toolkits is in nascent stage and is still classified as “emerging”. Since this is a recent phenomenon, it is essential to look for a proof of concept from the customer’s perspective. In this article, I aimed to do so by looking at the customer acceptance of smart customization offers with a focus on the smart toolkits. That is, I developed a technology acceptance model and collected empirical evidence from two product domains i.e. cars (263 respondents) and mobile phones (250 persons). As a general result, I uncovered that an almost large segment of customers of mass customization offers accept smart customizable products. Further, I revealed that the determination of customer acceptance is dependent upon, first, perceived usefulness, second, perceived enjoyment and third, perceived complexity of use. Finally, at the end of the paper, I derived a set of suggestions that opens up trajectories for future research on the smartness and adaptability that our products are turning into.*

Keywords: Customization, User Toolkits for Co-design, Smart Products, Consumer Preferences

Introduction

Customization is nowadays widely employed across diverse industries (Piller & Salvador, 2016). With the progress of communication and production technologies, firms are finally capable of responding to the individual needs of each customer at reasonable costs (e.g., Franke & von Hippel, 2003; Simonson, 2005). The most popular method applied is mass customization. The idea is to make use of some virtual user toolkits for co-design (UTCD) to assist customers in the customization process of their products. In so doing, the advantage lies in the fact that producers can retrieve effortlessly the customer's final custom design in order to produce and deliver the customized product "as is" (Pine, 1993).

Focusing on this area of research, most authors promote greatly mass customization (e.g., Franke & Piller, 2004; Franke, Keinz & Steger, 2009; Schreier, 2006). In particular, they demonstrated that it is, not only of considerable value from the firm's side but also the customer's one. They showed, for instance, that customers are ready to pay a considerable premium for having their product mass customized. Yet, for others, it is not without a downside effect (Bharadwaj, Naylor & ter Hofstede, 2009; Kramer, 2007; Simonson, 2005; Syam, Krishnamurthy & Hess, 2008). The lasted revealed by making use of prior research in consumer decision-making (e.g., Loewenstein & Prelec, 1993; Tversky & Kahneman, 1981), that mass customization is not well suited for certain customers. A great deal of evidence showed, indeed, that some customers, ignorant about their real preferences, are often dissatisfied with the customized product delivered to them. In this literature, it is explained by the fact that these customers are not able to articulate their unknown needs in the customization process and end up with some customized products that do not suit them (see, e.g., Syam et al. (2008) and lately Bharadwaj et al. (2009)). It appears to be particularly problematic knowing such persons are in majority in many product domains (Bettman, Luce & Payne, 1998). Against this background, Franke & Hader (2014) recently argue that mass customization is for everyone as long as UTCD act like "learning instruments". Based on the work of Moreau, Boney & Herd (2011), Payne, Storbacka, & Frow (2008), the authors showed that UTCD have to be design in the way to allow customers to have a feedback on their creations, learn from these experimentations what their preferences are and reiterate the process until they found the design that suits them the most.

That said, mass customization offers, even though being popular, remain with some limitations (von Hippel & Katz, 2002). One main thing is that they cannot provide feedbacks of the customer's different designs other than by computer simulations (Bharadwaj, et al., 2009; von Hippel & Katz, 2002). Thus, it stays challenging for the above-mentioned customers to mass customize utilitarian products. von Hippel & Katz (2001) illustrates it remarkably with the Dell Computer. While Dell enables the online customization of their computers in terms of the size of the hard drive or the number and type of memory modules, it is impossible to see UTCD acting as learning instruments. That is, unless customers are given the possibility to try their designs in real usage situations, they will never be able to discover what suit them the best.

Fortunately, with the advent of smart products, the emergence of a new customization approach is predicted in the literature (Bechtold, Kern, Lavenstein & Berhofer, 2014; Ernest-Jones, 2008; Porter & Heppelman, 2014; Thomke, 2016). I call it smart customization. The idea is to equip consumer products directly with some "smart" UTCD. The latter are composed of information and communication technology (ICT) in a form of software, microprocessors, sensors and other advanced electronics, which permit them to be integrated in any kinds of objects (see, e.g., Gross & Antons, 2009; Rijdsdijk, 2006). With such toolkits, the advantage is that they permit customers to customize their products to their immediate needs with a real and continuous learning effect (Gross & Antons, 2009; Thomke, 2016). For a better understanding of what is smart customization, let's illustrate it with the Adidas One sneakers and compare these shoes with Mi Adidas, being the mass customized versions of the classic sneakers (see Figure 1.1).

Article I. Smart Customization an Alternative to Mass Customization?



Figure 1.1. Mass Customization vs Smart Customization
Sources: adidas.com/us/customize / sneakersaddict.com

In the shoe industry, Mi Adidas proposes to mass customize their classic sneakers. Via a virtual UTCD shown in Figure 1.1, customers are empowered to customize four elements of the sneakers, what Adidas calls: sole, back, top, main in function of the colour and material. Once the customer finds his/her ideal combination, producers are then delegated with the task of manufacturing and shipping the final product to him/her within a period of 3 to 5 weeks. In contrast, with the Adidas one, customers have the possibility to customize the compression characteristics of the midsole by means of some smart UTCD embedded in the cushioning part of the shoes. With these systems composed of a small plus and minus console with five gradient factory settings, a microprocessor and a sensor, it is systematically possible to customize the hardness degree of the heel pads in real usage situations such as running, hiking, walking.

For the moment, there are other few early adopters either for rather utilitarian or hedonic products. There are, for instance, the Wiz smart connected lights, Lego Mindstorms or Tasker app for mobile phones. Yet, in the business press, it is foreseen that smart customization is likely to be current practice due to the proliferation of mobile phones, tablets and development of connected objects (e.g., Ernest-Jones, 2008; Porter & Heppelman, 2014; Thomke, 2016). For instance, Ernest-Jones (2008) stressed the fact, via a wide-ranging survey of over 600 senior

executives from diverse industries, that, 70% of them envision that their main products will be partly or fully customizable in the near future. Furthermore, for these executives, they see it as extremely feasible to smart customize products via data elements and software so as compared to tangible ones. In contrast, research on smart customization falls behind the reality. Rijdsdijk & Hultink (2003; 2009) are the first ones, next to Dhebar (1996) who brought into the management domain the notion of smarter and more adaptable products. Their focuses were, however, on the first generation i.e. Sony AIBO or the Electrolux vacuum cleaner. Ever since, smart products have been rather oriented towards cyber-physical systems that offer novel features based on connectivity (Bechtold et al., 2014; Thomke, 2016). Moreover, although the idea of customization with UTCD was addressed in the literature two decades ago (see., e.g., Franke & Piller, 2004; Franke & von Hippel, 2003; von Hippel & Katz, 2002), it is still described as “emerging” (Thomke, 2016). In particular, a key aspect that has received little attention is the customer’s perspective on these customization offers (Franke & Piller, 2003; Ihl, 2009; Piller & Salvador, 2016). Besides, so far, the effort has always been on mass customization offers (e.g., Dellaert & Dabholkar, 2009; Fiore, Lee & Kunz, 2004; Franke et al., 2009, Franke & Hader; 2014), whereas smart customization has merely none (Gross & Antons, 2009). Of course, it could be concluded that smart customization plays a minor role but, in fact, it is just the beginning of some promising research on the smartness and adaptability of our consumer products (e.g., Rijdsdijk & Hultink, 2003; Marketing Science Institute, 2016). Thereby, as a first step in this research, it is essential to comprehend further the determinants of customer-based success of smart customization offers. Evidently, the above mentioned existing literature on mass customization that explores the customer’s point of view on UTCD will be used as a solid groundwork.

Thereby, in this paper, it aims at examining the customer acceptance on smart customizable offers with the key element: smart UTCD and at investigating whether smart customization is a realistic alternative to mass customization. By following this trajectory, I adapted and tested a technology acceptance model (TAM) by relying on previous research on the acceptance of mass customization offers (Guilabert, 2005; Simonson, 2005; Thompson, Hamilton & Rust, 2005). In details, I linked the customer’s perceptions on smart UTCD (i.e. perceived usefulness,

perceived enjoyment, perceived complexity of use), on the product they own (i.e. feature fatigue, perceived product customization) so as certain personal traits of customers (i.e. customers who have insight into their preferences and those who do not have well defined, stable preferences) to the customer acceptance of smart UTCD. In this study, my empirical base is an online survey on two smart UTCD – both comparable to “apps” in the way they operate - one for cars and one for mobile phones. Besides, they both had distinctive samples i.e. cars (263 respondents) and mobile phones (250 persons). The clear finding is that smart UTCD are accepted by an almost as large segment of customers as the one for mass customization. In this regard, one interesting result is that customers who do not have well-defined, stable preferences are likely to accept smart customizable products because of the perceived enjoyment they are likely to derive from smart UTCD. This finding suggests that smart customization can be considered as a complementary alternative to mass customization for customers with unstable, undefined preferences that are unable to obtain what they want with the current customization offers.

Of course, my paper offers theoretical and managerial contributions. On the theoretical side, it, obviously, contributes to the recent literature on smart customization and smart products by providing deep knowledge on the concept and by mostly adding to our limited understanding of the customer acceptance of smart UTCD and its contingent factors (see, e.g., Gross & Antons, 2009; Hermans, 2014; Rijdsdijk, 2006; Thomke, 2016). Second, it extends previous marketing and consumer behaviour research on customization offers by uncovering the importance of the hedonic nature of UTCD and unveiling, for the first time in this research, the crucial role of perceived enjoyment for certain customers (see, e.g., Addis & Holbrook, 2001; Fiore et al., 2004; Franke et al., 2009). On the managerial side, it provides practical implications on the customer acceptance that can be easily applied in the development of the smart customization offers. Additionally, given that one of my samples of respondents is a good representation of the American population, the results of this study can be clearly interpreted as a customer demand for such products (Franke et al., 2009). Altogether, smart customization can definitely be considered as a realistic alternative to mass customization.

Literature Review

User Toolkits for Co-design

UTCD are described as some sets of coordinated design tools that assist customers to co-design their products via (1) a trial and error process and (2) a direct feedback on the creation outcomes (Thomke & von Hippel, 2002; von Hippel, 2001; von Hippel & Katz, 2002). With these systems, von Hippel (2001) brings the notion that firms and customers can be co-designers of those products fitting perfectly the individual needs. Among all co-designing approaches, UTCD plays a major role (von Hippel, 2001). It permits to solve the problem of what he called the “sticky information”. It is defined as a piece of customer need related information that is not easily transferable and usable from the customer’s recipient to the firm’s one (von Hippel, 1994; 1998). The reason is that the needs related information collected from the customers are too often ill defined, incomplete or changing too rapidly in the development of a product (Rosenberg, 1982). Instead, with UTCD, von Hippel’s pivotal idea is to shift the sticky information related design task to customers. It is realizable by equipping customers with UTCD (von Hippel, 2001). By means of these toolkits, users are able to uncover their latent needs by trying out diverse designs or solutions. Concretely, they are guided to transform their needs into a tangible design or solution via some iterative experimentations (Piller & Salvador, 2016). After that, firms, by retrieving the final option, are effortlessly able to have the exact needs related information that is used for the product development (von Hippel & Katz, 2002). In this regard, all UTCD have to follow certain design rules in order to fulfill their functions.

Based on von Hippel (2005, p.154), they must share the following characteristics:

- Some complete cycles of trial and error that guide customers to learn what they want in a given product domain
- A solution space that encompasses what the customers want
- A high degree of user friendliness, meaning, being operable by all customers prior to customization
- A library of commonly used modules that helps customers to create their custom designs
- Outcomes that are easily producible by firms

Furthermore, there are variants of UTCD that exist in the market place. Referring to Thomke & von Hippel (2002), their scope, that is the design possibilities, which are proposed, is a component that differentiates them. Based on this criterion, Frank & Schreier (2002) identified two types i.e. low-end and high-end toolkits. Explicitly, a high-end toolkit is characterized by a wider scope which permits customers to combine relatively basic and general-purpose building blocks and operations i.e. LEGO Mindstorms. In this scope, they are given the freedom to “co-create”, but, need to possess greater design skills (Prügl & Schreier, 2006). About the low-end toolkit, it has a narrow scope - a configurator like - which enables customers to combine a few pre-defined “options” from lists i.e. Adidas One and operate it easily.

Mass Customization: Values and Drawbacks

Mass customization is an approach that makes use of UTCD. In this context, UTCD are employed – mostly low-end ones – to support customers to find on the firm’s website the optimal combination for their customized product. Then, with the various sequences of computerized production machines, firms are left with the tasks of producing and delivering the customized product (Franke & Piller, 2003). Obviously, for firms involve in these customization activities, the purpose is to provide some custom artefacts at a cost that is finally reasonably competitive (Pine, 1993).

What is additionally valuable with mass customization is that it was proved to have mass appeal among customers (Pine, Peppers & Rogers, 1995). In fact, it is reinforced by a few empirical studies that demonstrated that customers are ready to pay a considerable premium for having their product mass customized (e.g., Franke & Piller, 2004; Schreier, 2006). What is notably interesting is that customers seem to value mass customization not only because of the preference fit it is likely to deliver, but also, because of the fun part they expect to derive from the process (Franke & Schreier, 2010). Fiore, Jin, and Kim (2005), for instance, revealed in their study within the fashion industry that customers intend to mass customize because of their expectations of an enjoyable experience. In the same line of research, Franke & Schreier (2010) found that the hedonic nature of UTCD has a significant impact on the user’s willingness to pay a premium. Further, in another stream of research, it is shown that the hedonic nature of

products plays also a role in their functionality (Van der Heijden, 2004). The author argues that it encourages customers to play around and so prolong extensively their uses. Thereby, it should considerably increase the likelihood to acquire the ideal custom design in customization. Actually, the producers of Mi Adidas understood it perfectly. They integrated important tactics that improve the hedonic nature of the UTCDC i.e. via videos of animated sneakers, very colorful and flashy images that push customers to have fun and use the tool extensively.

Yet, despite a general enthusiasm for mass customization, there are a few researchers, in contrast, that warned firms from certain limitations of this customization approach (Bharadwaj, et al., 2009; Kramer, 2007; Simonson, 2005; Syam et al., 2008). They argue, supported by a rich stream of research in decision making (for review, see e.g., Bettman et al., 1998; Loewenstein & Prelec, 1993), that mass customization is not suited for all customers but only for the ones who have insight into their true preferences. The other customers characterized as not having stable, well-defined preferences proved too many times to fail at creating a customized product they are satisfied with (Simonson, 2005). As posit further by Syam et al. (2008), it is indeed surprising to solicit such customers to articulate by themselves their unknown preferences in the design of their customized product. Yet, there is a more recent body of research that reveals that mass customization is not a niche but it is for all. (see, e.g., Franke & Hader, 2014; Moreau et al., 2011). In this literature, they argue that, as long as UTCDC perform like “learning instruments”, mass customization does not have to be restricted to certain customers. That is, these systems have to be built in the way that customers can be informed of all possible combinations available, test some of them, learn what they want from them and reiterate the process until the custom design is finally obtained. As Wind & Rangaswamy (2001, p. 15) posit “Its focus is to help customers to better identify or define for themselves what they want”. A slight drawback, though, is that the above claim holds for a majority of mass customization offers but not for all, that is, for offers which propose an aesthetic custom design of a product. However, from a strict logical perspective, it is not possible to infer that for rather utilitarian products (e.g., Dell computers, Mini motor vehicles), UTCDC have the potential to bring about comparable learning effects on consumers (von Hippel & Katz, 2002). Both authors illustrate it with the customization of Dell computers. As they said “unless customers can test

a computer design they have assembled before placing the order, they cannot perform the trial and error experiments needed to develop the product best suited to their needs”. In addition to this, there is, of course, an inherent risk that customers no longer like the customized product delivered to them (i.e. Mi Adidas sneakers delivery time takes up to 5 weeks), given their preferences change too rapidly (Rosenberg, 1982). Fortunately, with the advent of smart products, a new approach of customization by means of smart UTCD has emerged. Since then, customization is reinvigorating.

Smart Customization, a Mean to Serve Better the Customer's Individual Needs?

In tomorrow's industry, products will more and more likely be equipped with information and communication technology that turn them into smart products (Bechtold et al., 2014; Ernest-Jones, 2008; Rijdsdijk & Hultink, 2003; 2009; Thomke, 2016). Altogether, as envisioned by Rijdsdijk & Hultink (2009) and more recently by Bechtold et al. (2014), they will most likely possess – to a more or less extent – six abilities that make them greater than non-ICT products. That is, they are the autonomy, adaptability, multifunctionality, human like interactivity, reactivity and connectivity. From this literature, they illustrate it with the Electrolux vacuum cleaner that can operate by itself, the Sony AIBA that better responds to human users or the iPad that has a machine-to-machine communication. Since this first generation, there is the emergence of a new class of smart products identified as embedding smart UTCD. With these smart systems composed principally of data elements and software, the shared ability is to empower customers to customize their everyday products in a real usage situation to their current needs (Gross & Antons, 2009). That is, they have the benefit to provide a proper continuous learning effect to their users. This new approach of customization is called “Smart Customization” in this paper.

For a better comprehension of its advantages, let's take again the Adidas One as an illustration and explain the product in greater details. Adidas One are sneakers that integrate smart UTCD in the cushioning parts. By means of a small console that includes plus and minus buttons, customers are given the freedom to choose up to five gradient factory settings and adapt the compression characteristics of the midsoles whether they prefer a soft or firm ride. Now, let's

imagine that a customer selects one of the gradient factory settings. After that, smart UTCD will enable him/her to try out this setting in a real usage situation by adjusting automatically the degree of hardness of the cushioning. In so doing, he/she can discover if a particular setting misfits him/her, such as if he/she feels discomfort while evaluating the option. In view of that, he/she is left with the possibility to try another setting and repeat this operation until he/she identifies the best setting in the specific situation she/he is in.

Thereby, smart UTCD seem finally to be the UTCD that do act like “learning instruments”, especially for rather utilitarian products. Hence, they should be a perfect fit to customize for customers with no well-defined, stable preferences, given that their preferences are said to be defined over years shaped by the context they are in (e.g., Bettman et al., 1998; Fischhoff, 1991; Slovic, 1995). Next to it, smart UTCD also have the singular capability to allow customers to customize endlessly their product over its lifetime (Gross & Antons, 2009). Therefore, it means, that, with smart UTCD, it eventually permits each customer to obtain a product with a closer preference fit customized in a specific situation i.e. Adidas One. Obviously, it is, also, a benefit for firms as, in turn, it increases the customer satisfaction (Pine et al., 1995). Yet, rare are the applications of smart UTCD in the market place (Thomke, 2016). Further, literature on smart customization is still scarce. Thereby, in this context, it seems essential to have a better understanding of the customer acceptance. It is, notably fueled by some empirical studies conducted on mass customization offers, which clearly uncovered the importance of identifying the determinants of customer-based success of customization offers (e.g., Fiore et al., 2004; Ihl, 2009). Moreover, results from the customer acceptance are likely to be of value for firms, as it should provide them in depth knowledge on how to develop smart customization offers to meet the customer acceptance.

Conceptual Framework and Hypotheses

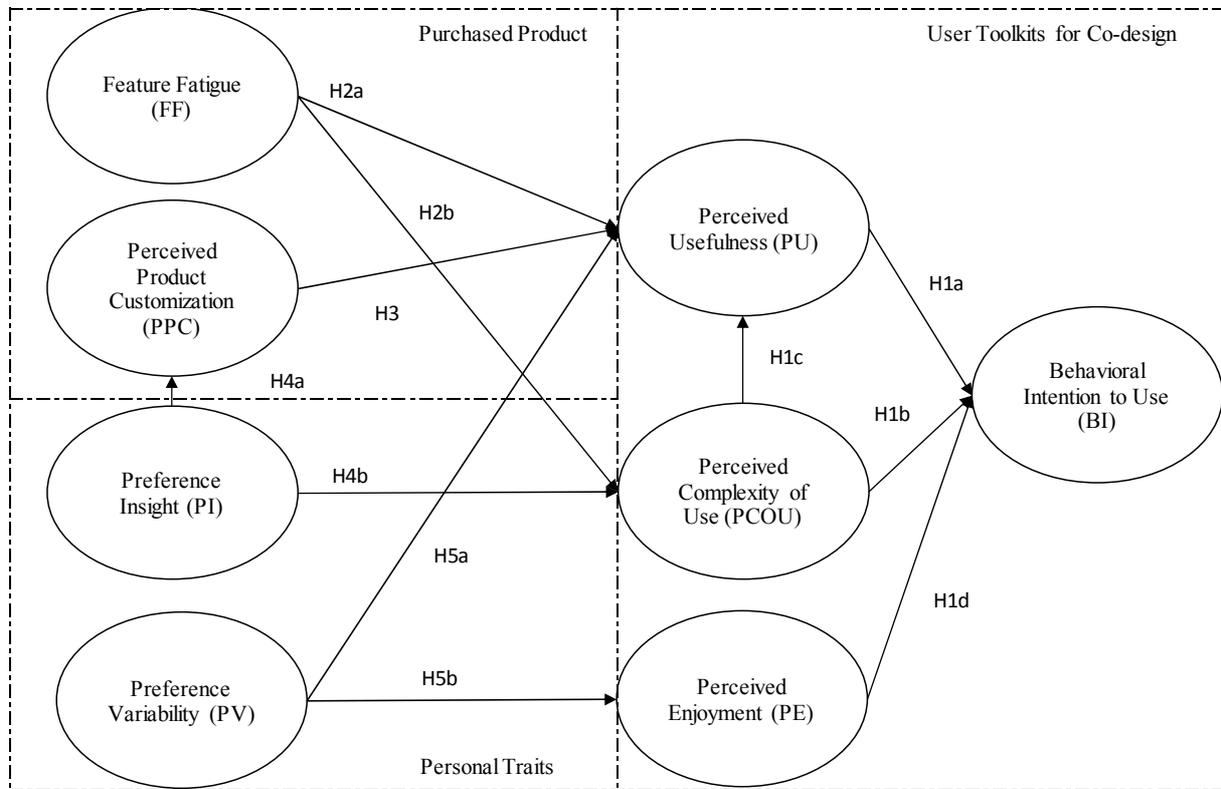


Figure 1.2. Proposed Model for the Empirical Study

For the present study, I developed the conceptual framework introduced in Figure 1.2. It consists of the original technology acceptance model and additional factors extracted from various discussions on customization (Guilabert, 2005; Simonson, 2005; Thompson, et al., 2005). The initial model comes from the information systems literature (Davis, 1989; Davis, Bagozzi & Warshaw, 1989) and aims at explaining the user acceptance of computers via three beliefs: *perceived usefulness* (PU), *perceived ease of use* (in our study employed as a reverse construct which is *perceived complexity of use* (PCOU)) and more recently *perceived enjoyment* (PE) (for perceived enjoyment see: Childers, Carr, Peck & Carson, 2001; Davis, Bagozzi & Warshaw, 1992). Focusing on the marketing literature related to mass customization, it is interesting to observe that the TAM is nowadays a common model, which is widely applied (Dabholkar & Bagozzi, 2002). It is not surprising knowing that the purchase of a product is always linked to its utilitarian and hedonic nature (Babin, Darden & Griffin, 1994; Hirschman & Holbrook, 1982).

In the paper, I define PU as the degree to which a person believes that using a system is likely to enhance his or her performance in fulfilling a certain task (Davis, 1989). Prior research in mass customization already showed that PU is essential by demonstrating it as having a positive influence on the customer intention to use UTCD (Piller, Ihl & Steiner, 2010). Moreover, I identify PCOU as “the degree to which a new product is perceived as relatively difficult to understand and use” (Rogers, 1995, p. 242). In an empirical study of Dellaert & Stremersch (2005), PCOU is established to be particularly relevant for customization offers as it showed to have a negative impact on the customized product so as the customization process. Therefore, it is likely that PCOU has a negative impact on the customer’s intention to use smart UTCD, particularly via PU. Also, I expect PCOU playing a role, knowing that, in the smart product literature, ICT is likely to add some intricacies in products (see, e.g., Bauer & Mead, 1995; Rijdsdijk, 2006). The reason is, as Den Burman (1997) and Rijdsdijk (2006) posit, that the electronics, microprocessors, sensors stay invisible and do their works in silence and so often miss a few understandable form elements to show customers on how to use them effortlessly. Regarding PE, I identify it as to the extent to which the activity of employing a system is perceived as enjoyable for its own sake (Davis et al., 1992). I expect this construct to be a strong determinant of the customer’s intention to use smart UTCD. Indeed, empirical studies in mass customization repeatedly revealed that customers evaluate customization offers not only because of the utilitarian nature i.e. empowering customer to create a product with a closer preference fit, but also because of the hedonic side, that is, the expectation of an enjoyable experience in the customization process (see, e.g., Addis & Holbrook, 2001; Hirschman & Holbrook, 1982). Following this, I formulated the hypothesis below:

***Hypothesis 1.** Customer’s behavioral intention to use smart UTCD is (a) positively influenced by perceived usefulness, (b, c) negatively (both directly and indirectly through perceived usefulness) influenced by perceived complexity of use and (d) positively influenced by perceived enjoyment.*

That said, although the basic TAM has been extensively exploited the way it was original developed (e.g., Davis, 1989; Venkatesh & Davis, 2000), the TAM is often tailored in the

marketing literature by adding context specific constructs. It has simply the advantage to yield a higher explanatory power (see, e.g., Dabholkar, 1996; Dabholkar & Bagozzi, 2002). Therefore, I added four determinants to the basic TAM to understand better the smart UTCD acceptance i.e. *feature fatigue* (FF), *perceived product customization* (PPC), *preference insight* (PI) and *preference variability* (PV).

Feature Fatigue

In today's industry, a growing number of smart products are overloaded by features i.e. multifunctional products (Poole & Simon, 1997). On the shelves, consumers often perceive all of these features as highly useful (Thompson et al., 2005). Thereby, they frequently opt for the overly ones (Schwartz, 2004). Yet, referring to Botti & Iyengar (2006), it is not surprising. As shown by these authors, it is just an automatic and unconscious process for customers but the more options that a product has the happier they are. However, once purchased, customers too frequently suffer from an overload of features (Piller et al, 2010). What is defined as feature fatigue (Thompson et al., 2005). That is, customers feel challenged and too overwhelmed with the sum of all features and sense incapable of obtaining a good grasp on the functionalities of their product. This is not unexpected since the capacity to process information is rather limited (Miller, 1956). Following this, I put forward the hypothesis below. I deduce, notably, that customers who experience feature fatigue in the product they own are likely either to perceive smart UTCD as adding intricacy or as being useful. It either is another feature to master on the top of the current ones or to assist customers to manage the bunch of features present in their product.

Hypothesis 2. Feature fatigue is (a) positively related to perceived usefulness and (b) positively related to perceived complexity of use of smart UTCD.

Perceived Product Customization

Perceived Product Customization depicts customers who possess already a customized artefact in a given product category (Guilabert, 2005). Referring to Hoeffler & Ariely (1999) and more

recently Piller et al. (2010), they are characterized as having good insight into their needs to the extent of being experts. Accordingly, they are likely to obtain exactly what they want only by mean of customization and therefore highly value it (Bharadwaj, et al., 2009; Franke et al., 2009). Consequently, I assume they probably intend to use smart UTCD in order to customize further and better the product they possess. My assumption, based on the above research on customization, is that these customers perceive smart UTCD as a way to obtain a closer preference fit with their product. Therefore, the following hypothesis is put forward:

***Hypothesis 3.** Perceived product customization is positively related to perceived usefulness of smart UTCD.*

Preference Insight

Preference insight represents customers who believe they know exactly what they want in a specific product domain. Referring to Simonson (2005), a majority perceives it right, thus, have good insight into their needs. Later, Piller et al. (2010) use this group of customers in order to show in an empirical study that they accept customization offers as it finally permits them develop and acquire products that suit what they exactly want. Additionally, as prior research shows that customer's needs are developed over time (Bettman et al., 1998; Fischhoff, 1991), it is likely that such customers possess an expertise in a certain product category (Simonson, 2005). Given this, it is most likely that they perceive smart UTCD as being easy to use. Accordingly, I developed the following hypothesis:

***Hypothesis 4.** Preference insight is (a) positively related to perceived product customization and (b) negatively related to perceived complexity of use of smart UTCD.*

Preference Variability

Preference variability defines customers who do not have stable and well-defined preferences in a selected product domain (Simonson, 2005). They are considered in majority in many product domains (Bettman et al., 1998). Besides, Syam et al. (2008) showed that they are likely to have a lack of expertise so as a difficulty to articulate what they truly want. For such reason,

they are likely to select a product for its fun aspect rather than its fit (Bettman, et al., 1998). In this regard, as a feeling of enjoyment from these customers is evoked when there are a large variety of options within products (Babin et al., 1994), it is likely that customers with preference variability use smart UTCD for the fun part. Additionally, based on the paper of Simonson (2005), it showed that such customers are identified to be highly receptive to any forms of assistance as they immediately recognize their ignorance in a product category. The author illustrates it by making use of the example of some motivated wine tasters. The latter are indeed likely to recognize immediately their ignorance in wines and inclined in getting guidance in this matter. Hence, as smart UTCD are clearly defined as some tools of guidance (von Hippel, 2001), it is likely that these customers perceive smart UTCD as a help to guide them in the development of their custom design. With these assumptions, the following hypothesis is put forward:

***Hypothesis 5.** Preference variability is (a) positively related to perceived usefulness and (b) positively related to perceived enjoyment of smart UTCD.*

Method

Empirical Setting

Two empirical studies were conducted to test the hypotheses developed in the previous section. In the interest of generalizing the results across diverse product categories, the empirical settings were selected within the following product domains: automobiles and mobile phones. These were chosen as they belong to industries, which have a diverse and huge consumer base from the American population (Ernest-Jones, 2008). Within these domains of product, two pioneering applications of smart UTCD were used as the empirical setting. Both applications were scenarized to test the concept on a panel of consumers via an online survey. The scenarization method is quite common for concept testing (e.g., Dabholkar, 1996).

That said, for the car study, a focus group was first conducted with ten experts from the automotive industry. About the mobile phone study, the same method was used, but with RWTH students. Both focus groups were asked to list all possible adaptability options of smart UTCD for either cars or mobile phones. Then, the options that belong to an identic subsystem, for instance, chassis for cars or call function for mobile phones, were put together. After that, scenarios related to the revealed adaptability options were described for both empirical settings. They are shown in the Appendix 1 of the dissertation. The scenarios selected were the most prevalent ones as they covered a large range of applications of smart UTCD. Next, such scenarios were retested on students with the purpose of avoiding confusions. Finally, for the mobile phone study, based on the previous work, a two minutes doodle video was created that included animated images of scenarios and a short description of smart UTCD. That is, after introducing briefly smart UTCD for mobile phones as being “some smart tools which give users the freedom to adapt their phones’ features to their individual needs with easiness and intuition”, the video contained a series of scenarios, which give an overview of how respondents could employ smart UTCD. Among many, one of the applications shown of the phone adaptability is described as follows: It permits to connect the phone calendar with some of the other phone features. By doing so, the phone calculates automatically the required transit time from the user position to the appointment’s place and informs him/her via pop up notification when it is time to leave. Moreover, it can automatically launch the navigation system with the

right destination on the way to the meeting. Regarding the cars' study, it consisted of a description of a toolkit for cars realized out of texts and pictures. In total, eight scenarios were developed to explain smart UTCD and the variety of the applications (for further details, see Piller et al., 2010). Each scenario presented an adaptability of the different parts of the cars i.e. cockpit, seats, ambiance-system, electronic control units, communication and infotainment services, engine, chassis, body. Altogether, with both applications for cars and mobile phones, the shared idea is to enable customers to have the entire control over the functionalities of their product and to customize them so that they meet their individual needs.

Data Sample

To assess the smart UTCD acceptance from customers, two distinctive samples of respondents were selected in each of the two product categories, meaning either cars or mobile phones. This ensured us that respondents were familiar with the selected product.

First, as an exploratory study, I employed an external data set from a previous study on cars (Piller et al., 2010). The former was gathered from an online survey realized on a sample of respondents from miscellaneous mailing lists of car owners via car associations. The questionnaire, similar to the phone study, was sent to the car owners' communities by email. This resulted in 263 usable questionnaires. The data collected from this survey was directly provided to me.

Then, the second study was conducted - which was essentially a replication of the cars' study but targeting mobile phones' owners. The difference is that this study used an extremely reliable sample, which is a crucial aspect of this research. The latter was in fact elaborated by an online research firm from a pool of android phone users in return for financial incentives. The panel consisted of 250 respondents who varied in gender, age, educational level and income level. It had the following structure:

- Gender quota: male (49%), female (51%)
- Age quota: 18-24 years (18%), 25-34 years (21%), 35-44 years (21%), 45-54 years (23%), 55-65 years (18%)

- Education quota: low (46%), middle (28%), high (26%)
- Income quota: 44% low (up to 39.999 \$), 25% middle (40.000 - 69.999 \$), 31% high (more than 70.000 \$)

The questionnaire was also administrated online.

Procedure

Although the two empirical studies for cars and mobile phones were conducted separately, the process of doing the survey and the survey itself were similar. Respondents received an online questionnaire and they had a week to fulfill the survey. Each of them was provided with descriptive scenarios of how smart UTCD for either cars or mobile phones are employed. After that, panelists were asked to assess on how useful, complex and enjoyable they perceive smart UTCD. Third, they were solicited to evaluate the product they possess i.e. their car or mobile phone in terms of feature fatigue and perceived product customization. Finally, in the last section of the questionnaire, they responded to questions related to their personal traits as consumers (i.e. preference insight and preference variability). Besides, at the end of the questionnaire, they were finally asked, as it is common practice in such studies (see, e.g., Davis, 1989), to disclose personal information i.e. their age, their income, their educational level and their gender.

Measurement Instrument

To measure user acceptance of smart UTCD and its determinants, all constructs in the model were operationalized using validated items from the relevant literature as often as possible. The constructs “behavioral intention to use” and “perceived complexity of use” were for instance obtained from Thompson, Higgins & Howell (1991) and Venkatesh, Morris, Davis & Davis (2003), whereas “perceived enjoyment” was measured using four items developed previously by Childers et al. (2001). All details of these measurements scales are shown in the Appendix 3 of this dissertation.

With regard to perceived usefulness, the construct could not be assessed based on the original scale of Davis (1989). Indeed, certain items like the ones related to the job performance are

irrelevant for smart UTCD. Moreover, in the literature (e.g., Ihl, 2009; Van der Heijden, 2004), it is recommended for this specific construct to find a scale that suits the technology that is studied. Therefore, focusing on the study for cars, an own scale for perceived usefulness was developed by Piller et al. (2010). About the mobile phones' study, I found new items from Franke et al. (2009) and Schreier (2006) that captured the utilitarian nature of smart UTCD i.e. the subsequent items were: "Compared to standard mobile phones, using a mobile phone with smart UTCD would better satisfy my requirements"; "Compared to standard mobile phones, using a mobile phone with a smart UTCD would meet my personal preferences"; "Compared to standard mobile phones, using a mobile phone with a smart UTCD would more likely fit my image of a perfect mobile phone" (1= "strongly disagree", and 7= "strongly agree"; Cronbach $\alpha = .94$).

Feature Fatigue. This construct was measured based on the items used by Piller et al. (2010). They are employed as follow in this paper "It is easy to get [my mobile phone/car] and all its features to do what I want them to do"; "[my mobile phone/car] contains too many irrelevant features that are not of interest to me"; "Many features of [my mobile phone/car] are basically useless to me"; "Using certain features of [my mobile phone/car] is often difficult and exhausting" (1= "strongly disagree", and 7= "strongly agree"; Cronbach $\alpha = .84$).

Perceived Product Customization. Four items were extracted from Piller et al. (2010) to measure perceived product customization. Some are inspired by the ones elaborated by Guilabert (2005). The items are: "For [my mobile phone/car] I chose an individual combination of features"; "When buying [my mobile phone/car], I paid special attention to certain features that meet my preferences"; "I try to customize [my mobile phone/car], so that it would exactly fulfill my individual needs"; "[my mobile phone/car] is almost identical and unaltered compared to the standard or base model" (1= "strongly disagree", and 7= "strongly agree"; Cronbach $\alpha = .88$).

Preference Insight. Preference insight was measured by means of 3 items like the ones used by Piller et al. (2010) so as Franke et al. (2009). Finally, the items are used as follow:

“Regarding [my mobile phone/car], I know exactly what I want”; “When I purchase [my mobile phone/car], I usually know quite soon what I prefer”; “When I purchase [my mobile phone/car], I find it easy to choose among different alternatives”. The scale is anchored “strongly disagree – strongly agree” on a seven points Likert scale; Cronbach $\alpha = .90$.

Preference Variability. Items taken to measure this construct were extracted from Piller et al. (2010) and Simonson (2005). They are read as follow in the study: “My preference concerning [mobile phone/car] features and characteristics constantly change”; “I often have changing or even new requirements for [my mobile phone/car]” (1= “strongly disagree”, and 7= “strongly agree”; Cronbach $\alpha = .86$).

Of course, a pretest of the measurement scales was conducted targeting academics and non-academics to ensure that the scales were adapted and understood appropriately within the defined contexts. Following this, minor wording changes were applied to the questionnaire.

Estimation

To test the hypotheses, the structural model was estimated. Thereby, the estimation technique for the structural equation model (SEM) was selected. For both studies, partial least squares (PLS) were favored over maximum likelihood (ML) methods. This decision was mainly motivated due to the distributional assumptions and required distinct sample sizes in these two methods (Chin, 1998; Chin & Newsted, 1999; Fornell & Bookstein, 1982). In addition, as the perceptual theories were never applied for smart UTCD, my research had an exploratory nature (Rijsdijk & Hultink, 2009). Therefore, it was decided to select variance based SEM i.e. PLS. It is indeed a better fit for theory development, meaning, the focus is mainly on the predictive power of a model (Chin & Newsted, 1999; Wold, 1985). Then, accordingly, my data was analyzed with the software SmartPLS (Ringle, Wende & Will, 2005).

Results and Analysis

Measure Assessment

Exploratory and confirmatory factor analyses were undertaken to examine the reliability and validity measures of the constructs. In this regard, I first conducted an exploratory analysis to establish the factor structure. As shown in Appendix 3, it resulted in extracted factor variances above 70%, items to total correlations above 0.5 and the Cronbach's alphas coefficients exceeding the 0.7 threshold (Nunnally, 1978). With these findings, I prove a high reliability for all measurement scales. Besides, I realized a confirmatory factor analysis via SmartPLS. Resulting from it, I reveal, next to confirming again the constructs' reliability with the latent composite reliabilities (higher than the threshold of 0.80 (Fornell & Larcker, 1981)), with the computation of the average variance extracted (AVE), the unidimensionality and a high convergent validity of the constructs. Explicitly, all AVE values are above the required threshold of 0.6 (Fornell & Larcker, 1981). Such results are shown in Table 1.1.

Table 1.1. Reliability and Validity of the Measures

	Car		Mobile Phone	
	Composite Reliability	Average Variance Extracted	Composite Reliability	Average Variance Extracted
Behavior Intention to Use	0,86	0,76	0,96	0,85
Perceived Complexity of Use	0,89	0,67	0,97	0,89
Perceived Product Customization	0,9	0,75	0,92	0,8
Perceived Enjoyment	0,94	0,8	0,97	0,88
Feature Fatigue	0,87	0,63	0,9	0,75
Preference Variability	0,93	0,87	0,93	0,87
Preference Insight	0,91	0,84	0,94	0,83
Perceived Usefulness	-	-	0,96	0,9

Regarding the discriminant validity, based on Chin (1998), it is acceptable when the square root of the AVE of each construct is larger than the values of its correlations with the other constructs. Therefore, as it is shown in Table 1.2 and 1.3, I confirm that the discriminant validity is suitable in both studies. In detail, the square roots of AVE (indicated in boldface in the matrices) appear always to be larger than the cross correlations. Altogether, the analyses prove that all constructs are acceptable.

Table 1.2. Correlations between Variables and Square Roots of the Average Variance Extracted (Mobile Phones)

	Behavior Intention to Use	Perceived Complexity of Use	Perceived Product Customization	Perceived Enjoyment	Feature Fatigue	Preference Variability	Preference Insight	Perceived Usefulness
Behavior Intention to Use	0,92	0	0	0	0	0	0	0
Perceived Complexity of Use	-0,45	0,94	0	0	0	0	0	0
Perceived Product Customization	0,43	-0,25	0,90	0	0	0	0	0
Perceived Enjoyment	0,82	-0,35	0,39	0,94	0	0	0	0
Feature Fatigue	-0,07	0,36	0,09	-0,12	0,87	0	0	0
Preference Variability	0,38	-0,13	0,48	0,32	0,22	0,94	0	0
Preference Insight	0,15	-0,14	0,46	0,12	0,08	0,30	0,91	0
Perceived Usefulness	0,87	-0,42	0,44	0,76	-0,01	0,38	0,14	0,95

Note the square root of the average variance extracted is shown in bold

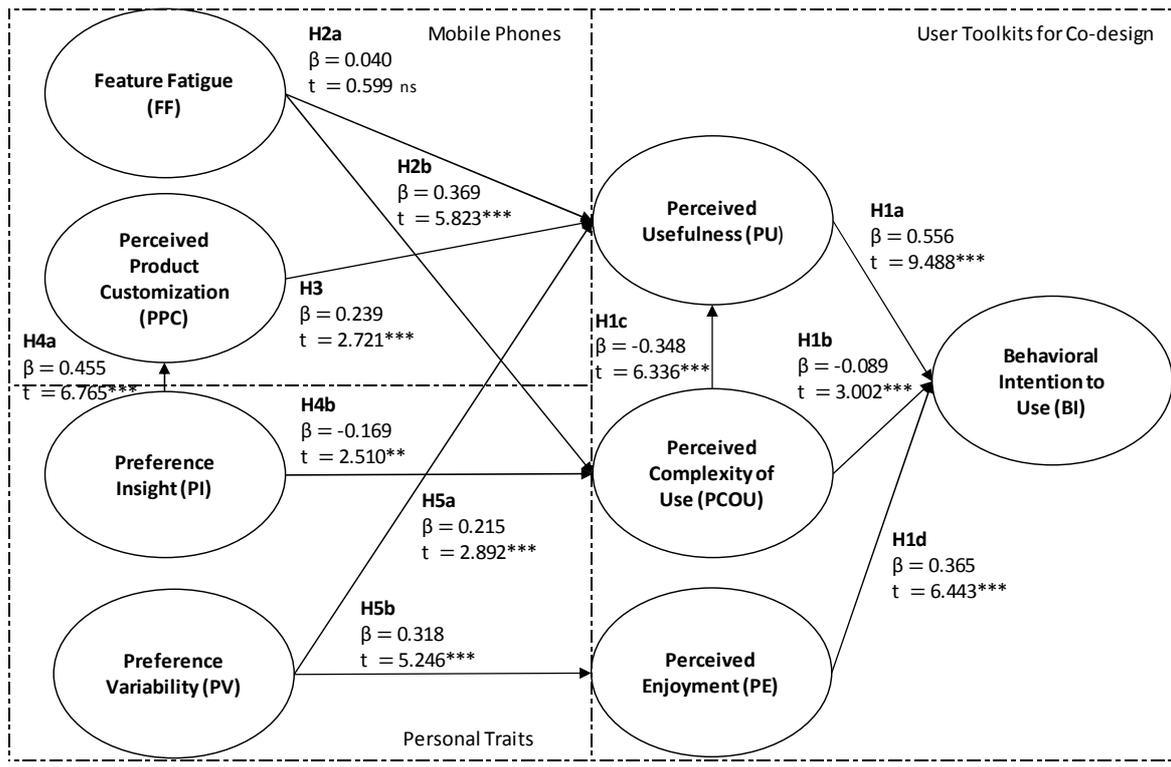
Table 1.3. Correlations between Variables and Square Roots of the Average Variance Extracted (Cars)

	Perceived Complexity of Use	Perceived Product Customization	Perceived Enjoyment	Feature Fatigue	Preference Variability	Preference Insight	Behavior Intention to Use	Perceived Usefulness
Perceived Complexity of Use	0,82	0	0	0	0	0	0	0
Perceived Product Customization	-0,11	0,86	0	0	0	0	0	0
Perceived Enjoyment	-0,40	0,09	0,89	0	0	0	0	0
Feature Fatigue	0,1	0,07	-0,1	0,79	0	0	0	0
Preference Variability	-0,17	0,09	0,3	0,07	0,93	0	0	0
Preference Insight	0,05	0,36	-0,09	-0,15	0,04	0,92	0	0
Behavior Intention to Use	-0,43	0,12	0,61	0,08	0,36	-0,08	0,87	0
Perceived Usefulness (Formative)	-0,43	0,24	0,65	0,1	0,27	-0,01	0,64	0

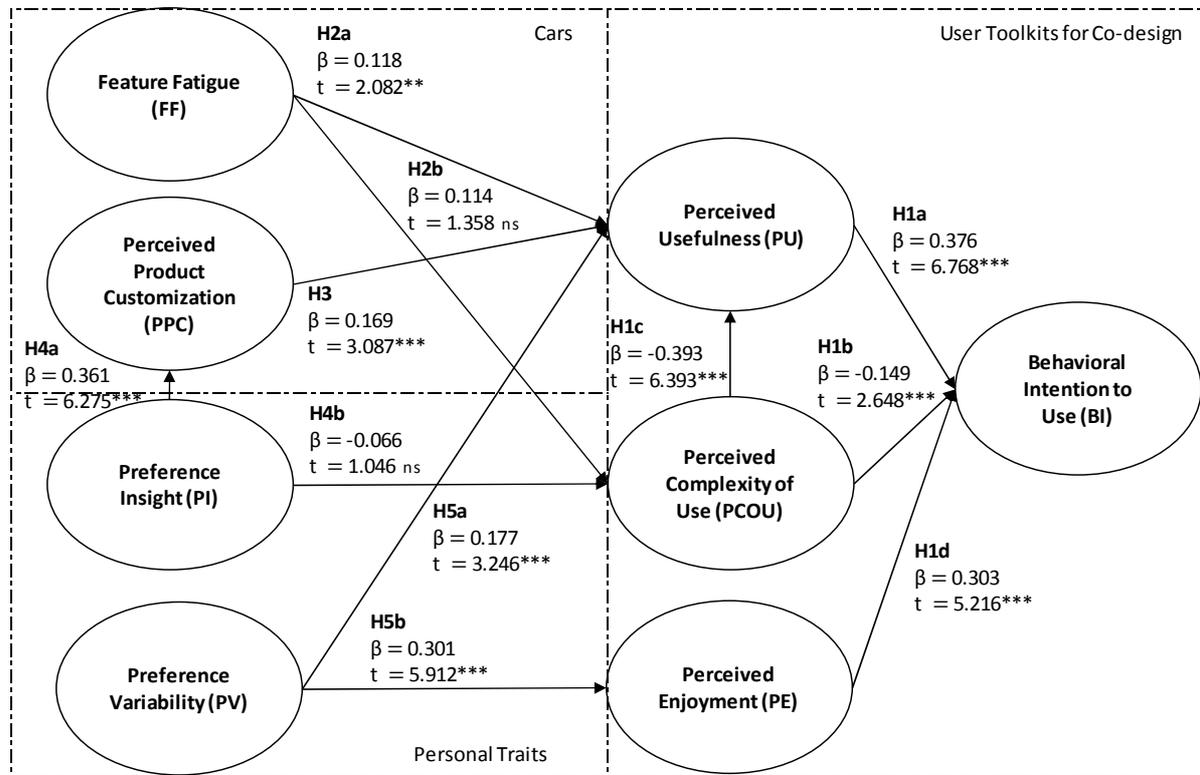
Note the square root of the average variance extracted is shown in bold

Model Estimation: Results of the Structural Equation Models

After assessing the reliability and validity measures of the constructs, the models were estimated. Results are presented in Figure 1.3 for mobile phones and in Figure 1.4 for cars. With these findings, I confirm the structural models and most hypotheses made.



Notes: ***, $p < .01$; **, $p < .05$; *, $p < .1$; (ns): not significant; two-sided test.
 t-values obtained from bootstrapping re-sampling with 500 samples and sample size 250
Figure 1.3. Results Obtained for the Structural Model (Mobile Phones)



Notes: ***: $p < .01$; **: $p < .05$; *: $p < .1$; (ns): not significant; two-sided test. t-values obtained from bootstrapping re-sampling with 500 samples and sample size 263

Figure 1.4. Results Obtained for the Structural Model (Cars)

Clearly, in Figure 1.3, all hypotheses made are confirmed apart the one that links FF and PU. In Figure 1.4, all the hypothesized paths are significant except two: the path between FF and PCOU and the one between PI and PCOU. Moreover, as a general finding, it is interesting to notice that, in both models, PU is the first predictor of BI for the smart UTCD acceptance with 0.376 (cars) and 0.556 (mobiles phones) followed closely – it is particularly obvious for cars – by PE with 0.303 (cars) and 0.365 (mobiles phones). Such findings are in line with previous marketing research on customization offers that shows both factors are almost equally important in the customer acceptance structure (see, e.g., Fiore et al., 2004; Ihl, 2009). Yet, it is for certain authors quite unusual to see that PE and PU have almost the same significance. Referring to Davis et al. (1992) or more recently Van der Heijden (2004), products are accepted by customers due to either their hedonic or utilitarian nature but not both. Concerning PCOU, its negative effect on BI is not as critical as expected with a weak direct effect of -0.149 (cars) and -0.089 (mobile phones). Yet, PCOU is more problematic via PU with a rather stronger

indirect partial effect of -0.393 (cars) and -0.348 (mobile phones). Such finding, though, is not surprising when knowing the customization literature (see, e.g., Ihl, 2009). As an example, prior research from Dellaert & Stremersch (2005), for instance, revealed that the customer's perception of complexity on a customization offer has a strong negative impact on its utility.

Next, focusing on the cluster of the respondent's perceptions on the product they own (i.e. their cars or mobile phones), it is observed that PPC has, as predicted, a significant positive effect – it is the third predictor of BI after PU and PE – on PU in both product domains. In contrast, concerning FF, half of the hypotheses were not validated. Explicitly, the FF's effect is neither significant on PCOU in the car study nor on PU in the mobile phone one. One explanation could simply be that smart UTCD cannot be interpreted in both ways i.e. being perceived as adding intricacy within the product they own and as being perceived as useful. While smart UTCD for cars are perceived as useful via FF, the one for mobile phones is seen as adding complexity. About the second cluster linked to the personal traits of consumers, all hypotheses made are validated. Both PI and PV have a positive effect on PU, the effect of PI being indirect via PPC i.e. for PV, 0.177 (cars) and 0.215 (mobile phones) so as for PI, 0.361 (cars) and 0.455 (mobile phones). Additionally, PV has a significant and positive influence on PE i.e. 0.301 (cars) and 0.318 (mobile phones), the latest path being, as predicted, stronger than the one on PU. Such results confirm what Bettman, et al. (1998) stated, that is, customers who do not have well-defined preferences prefer smart UTCD with fun aspects rather than because of the fit they could deliver. Finally, the last findings of PI on PCOU reveal in both studies - even though weak - the positive influences i.e. -0.066 (cars) and -0.169 (mobile phones). The interpretation is that it is less likely to perceive smart UTCD as complex when customers have insight into their preferences. It makes a lot of sense, given that these customers have most probably an expertise in the selected product domains (Hoeffler & Ariely, 1999).

Discussion and Further Research

In this paper, I introduced further the concept of “smart customization” which has been made possible with the advent of smart products. Inspired by the work of Gross & Antons (2009), Hermans (2014) and more recently Thomke (2016), the idea is to equip our everyday products with smart UTCD so that customers are given the possibility to customize the product they own. Unlike mass customization, the advantage is that they support real and continuous learning effects. Until now, prior research has principally focused on mass customization offers, especially regarding the customer’s perspective (e.g., Dellaert & Dabholkar, 2009; Fiore et al., 2004; Ihl, 2009), there is barely research on smart customization (Piller et al., 2010). Thereby, the aim of the paper was to look – like for every new class of products – at the customer acceptance on this new concept by means of the key element: smart UTCD, that is, to investigate the acceptance of smart UTCD from the customer’s point of view and its contingent factors. As a general finding, it showed that - so as with mass customization offers - smart UTCD acceptance is explained, first, positively by perceived usefulness, second, positively by perceived enjoyment and third negatively by perceived complexity of use. Beyond it, the study uncovered the personal traits of consumers that accept smart UTCD. It appears that they are the ones with preference insight who possess a customized product prior to the integration of smart UTCD so as, most of all, the ones with preference variability. With these findings, it permits us to conclude that smart customization is not only on theory a valuable alternative to mass customization but it is, also, a realistic one. In details, it seems to be, most importantly, the right customization method for customers with no stable, well-defined preferences, who were identified in the literature to like customization offers, but end up too often dissatisfied with the current customization offers (Bharadwaj et al., 2009; Franke et al., 2009; Pine et al., 1995). Yet, it is important to emphasize that mass customization is still of high importance. It clearly remains the right option, so as revealed in the literature (Simonson, 2005; Syam et al., 2008), and confirmed by my findings, for customers who have insight into their preferences (i.e. my results indeed do not show that these customers are appealed by smart customization offers). Referring to Simonson (2005) and more recently Piller et al. (2010), these customers appear rather to use and be satisfied with mass customization offers, as they permit them to transform

and crystallize their individual preferences into one final customized product. Finally, in what follow are further details of the findings.

First, the study reveals the principal reason why customers accept smart UTCD; it is due to the utilitarian value. In fact, it is predictable as UTCD are conceived for an utilitarian purpose as described in the seminal literature (Thomke & von Hippel, 2002; von Hippel, 2001; von Hippel & Katz, 2002). The principal focus is clearly to support thoroughly customers in their efforts to customize their ideal products. It is especially apparent, in my paper, with the mobile phones' study where perceived usefulness is by far the most important determinant of the smart UTCD acceptance. Indeed, the smart UTCD' aim is evidently to manage, merge and adapt the functionalities of the customer's phones to each of his/her individual preferences i.e. combine the alarm clock with the agenda and the weather forecast in order to be waken up on time for an early business meeting.

Then, perceived enjoyment is the determinant following closely perceived usefulness in the explanation of the smart UTCD acceptance. The strong effect - so as compare to other TAM studies such as from Davis et al. (1992) or Van der Heijden (2004) - of the construct "perceived enjoyment" on "behavioral intention to use smart UTCD" makes it evident. Previous research on mass customization also revealed similar outcomes (Addis & Holbrook, 2001; Fiore et al., 2004; Hirschman & Holbrook, 1982). Explicitly, it shows that customer's readiness for mass customization offers is motivated by both the hedonic expectation of a fun experience while customizing with UTCD and, to a stronger degree, by the utilitarian notion of creating an own product with a closer preference fit. Subsequently, a suggestion is for firms to exploit this finding further by accentuating the fun aspect of smart UTCD. As individuals seek for the fun aspects of a product on multiple sensory ways (Holbrook & Hirschman, 1982), it is the trajectory to follow to increase the hedonic nature of UTCD. Taking, notably, as an example mass customization offers, it is achievable with the inclusions of hedonic content, animated images, sounds and esthetical visual aspects. Furthermore, literature on value creation in this regard repeatedly revealed that the feeling of enjoyment is an important side effect of customization (Franke & Schreier, 2010; Franke, Schreier & Kaiser, 2010; Schreier; 2006). Lastly, it is important to stress the fact that the hedonic nature of smart UTCD has also a

functional benefit. As demonstrated by Van der Heijden (2004) and supported by Franke & Hader (2014), it encourages customers to prolong their uses which, in turn permit them to construct so as identify their preferences over time, and thus, finally, increase their chance of creating what they exactly want.

Third, perceived complexity, even though of a weak effect, has a negative influence on the customer acceptance. It, indeed, appears evident that customers do not intend to use smart UTCD if they sense the tools can bring some intricacy into their products. Further, given that smart UTCD consist of ICT components; perceived complexity remains a factor to pay attention to, based on the literature on smart products (e.g., Bauer & Mead, 1995; Norman, 1998; Rijdsdijk, 2006). Bauer & Mead (1995) and lately Norman (1998), for instance, mention that consumers often view smart objects as being hard to read with regard to their usability. That is, the product's form usually gives users some hints on how to understand and categorize them but, with the recent integration of ICT, this relationship is no longer feasible (e.g., Bloch, 1995; Rijdsdijk, 2006; Veryzer, 1995). In details, such components are often hidden within the products and do their works in silence (Den Buurman, 1997). Thereby, for customers, it has often a lack of affordance and can be viewed as being complex to use (Bauer & Mead, 1995). In various literature, to prevent firms from such issue, it is strongly advocated to focus on the importance of developing an adequate, user-friendly interface design (see, e.g., Den Buurman, 1997; Feldman, 1995; Han, Yun, Kwahk & Hong, 2001; von Hippel, 2001).

Furthermore, with this TAM study, one could also obtain findings on the personal traits of consumers likely to accept smart customization offers. The main outcome is that the segment of customers for whom smart UTCD are accepted is as almost as large as for the one of mass customization. It includes customers who have insight into their preferences and possess, prior to the smart UTCD' integration, a customized product so as the ones who do not have well-defined, stable preferences. Besides, what is also noteworthy with this finding is that because if the fact that I did not use conveniently a sample of students but respondents that are representative of the American population, this result can additionally be interpreted as a customer request for smart customization offers.

About customers with preference variability, results show that the smart UTC D acceptance is unusually influenced by first perceived enjoyment, and after that perceived usefulness. One explanation of the finding can be found in the paper of Bettman, et al. (1998) which revealed that these customers, because of their poor knowledge of what they prefer, are unable to select a product in function of its usefulness but only in function of the feeling of joy, they are likely to have. Following this, as products with a high variety of options (i.e. the high number of adaptable features for smart UTC D) are established as evoking this feeling (Babin et al., 1994; Botti & Iyengar, 2006; Schwartz, 2004), it can be the reason why these customers are ready to use smart customization offers. However, beyond it, what the finding indicates is that firms should consider smart customization as a relevant alternative to mass customization for such customers, given they are often in majority in many product domains (e.g., Bettman et al., 1998; Loewenstein & Prelec, 1993). Additionally, by focusing on the ones who do not have stable preferences, smart customization seems particularly suited for them. Indeed, it should finally enable them to adapt the product they own to their current preferences. Therefore, it appears only advantageous for producers to propose these offers as it clearly reduces the risk to have customers who are dissatisfied, knowing it was the case with mass customization. Yet, a question is worth addressing for future research. That is, whether these customers can select by themselves a smart customizable product, which is easily operable by them (i.e. number of adaptable features available, visual aspects, help functions) and which is likely to serve them well in the customization process. Based on Schwartz (2014), it might remain problematic. As posit by the author, it is likely to be related to the paradox of choice, meaning, such customers tend to select products with a high number of features but are not able to deal with them at the usage stage, which results frequently in the give up on their product.

Additionally, my findings reveal that a sub group of customers who have insight into what they want are likely to accept smart UTC D. They are, furthermore, identified as possessing already a customized artefact in the given product domain. As hypothesized, my findings show they are likely to employ smart UTC D rather for utilitarian reasons. In the literature, such customers are characterized as experts in their domain who highly value customization (Bharadwaj et al., 2009; Franke et al., 2009; Hoeffler & Ariely, 1999). Thereby, an interpretation is that smart

UTCD are likely to be perceived by them as new opportunities to customize further and better their already customized products. The assumption is that smart UTCD such as the ones employed in this study, are likely to be useful for them to better centralize, customize, and manage the specific features they already selected in their products. It would be interesting to continue this investigation in a future research; a suggestion is to look at the customer's perspective during the usage of smart UTCD. One can, for instance, add to the recent research the customer's affective reactions induced by interaction with UTCD, such as product satisfaction (Valenzuela, Dhar, & Zettelmeyer, 2009), pride of authorship (Schreier, 2006) and enjoyment (Franke & Piller, 2004).

Of course, this study is not without limitations, which constitute additional opportunities for further research on smart customization. First, my research may need to strive for generalization. That is, these findings are likely to be generalizable to other smart UTCD identical in nature and embedded in products owned by a majority of customers. For instance, a smart UTCD that could be selected for another study is the Philips lighting control system that consists of a smart UTCD, which is an app, that controls the customization of connected, adaptable bulbs. Yet, the relevant question is whether these findings are generalizable for smart UTCD that act like configurators i.e. the Adidas One. Logically, it is not possible to deduce that similar results can be obtained. Thereby, another idea would be to reproduce the study, having such smart UTCD as settings.

Concerning how the study was conducted, a limitation has to be notified to readers. That is, it is scenario based. Hence, while all efforts were made to develop realistic manipulations of scenarios, it is likely that panelists act differently in a real purchase situation (Guilabert, 2005). Even though it is current practices in research to use scenarios (e.g., Dabholkar, 1996), such shortcoming is an opportunity for extra research. An obvious one is to provide respondents with smart UTCD and reproduce this study. The latest method is closer to the reality because of the real test in use panelists are able to perform.

Furthermore, it should be reported that the study used two different data sets i.e. one of the two is extracted from a preliminary study realised by Piller et al. (2010). Of course, it would have

been better for the reliability of this study to use two reliable samples of respondents generated by the same online research company and to collect data from the exact same online survey.

Moreover, I favored PLS over other methods like ML (differences between maximum likelihood methods and partial least squares are essentially in Chin (1998), Fornell & Bookstein (1982) and Vilares, Almeida & Coelho (2010)). Although Vinzi, Chin, Henseler & Wang (2010) so as Coelho & Henseler (2012) rehabilitated PLS as a reliable method in marketing research, it remains not a customary method in the field of marketing.

Besides that, while the technology acceptance model was thoroughly developed based on various discussions on customization offers - i.e. the factors related to the customer's personal traits were extracted from Bharadwaj et al. (2009), Franke & Hader (2014) and Simonson (2005) and the ones on the products that embed smart UTCD from Guilabert (2004), Thompson et al. (2005) and Piller et al. (2010) - some other perceptual constructs such as "product satisfaction" or constructs related to consumer differences like "perceived expertise" would have helped to explain further the smart UTCD acceptance. (Dellaert & Stremersch, 2005; Ihl, 2009)

Additionally, the focus is on smart UTCD integrated into ordinary products such as shoes, mobile phones, cars etc. Yet, another type exists in the market place, which was not addressed in the paper and may be viewed to a certain extent as a limitation. It could be seen, however, as a great opportunity for future research on the phenomenon of smart customization offers. That is, lately, the emergence of use generative goods that employ smart UTCD (Brown, 2013). There are described by the author as a small group of products – the X Box being one of them – that, somehow, encourage customers to generate disruptive uses far from their original uses (i.e. surgeons, for instance, use in an unusual way the X Box in their practices). With these products identified to generate uses from their customers, producers are very frequently obliged to provide their clients, after consideration, some smart UTCD in order to support their efforts to create. Thereby, the purpose of these smart UTCD is different from the ones studied in the paper. While one kind aims at supporting the user's effort to generate further disruptive uses, the other is rather present in mature markets to permit a customization of ordinary products. Hence, it would be interesting to reproduce the study with some use generative goods and their

smart UTCD as empirical settings. An adaptation of the technology acceptance model is, however, necessary. In this setting, it would be recommended to switch the constructs related to the customer's personal traits linked to the literature on customization offers (i.e. preference insight and preference variability) to the lead user characteristics that can be extracted from Franke, von Hippel & Schreier (2006), Ihl (2009) or von Hippel (1986).

Finally, other research aspects derive from this study could be addressed in additional research. For instance, a question that arises is how customers select one smart UTCD format over another and if they select to their advantages. Additionally, it can be worth pursuing on focusing on the design of the adequate solution space for the target customers. So far, as mentioned by Piller (2005), despite the importance of this design aspect in UTCD, there is hardly research on it. A reason why could be that, with mass customization, customers always have the option to abandon if the UTCD they try do not suit them. Nowadays, with smart customization, as smart UTCD are part or the entirety of a consumer product, the impact of an incorrect solution space is likely to be more consequential. Finally, yet importantly, my study opens up a promising path for future research on smart customizable products. So far, one could observe – so as shown in this paper – smart customizable products for rather utilitarian reasons i.e. Adidas one, Tasker, etc. However, given the proliferation of mobile phones and connected products, this kind of product is likely to be extensively developed, as the differentiation is easily made by data elements and software (Ernest-Jones, 2008). However, in the future, with the progress in nanotechnology, smart customizable products are likely to be customized for aesthetical reasons i.e. customization of a car in function of the colours or materials (in a lecture of Professor Dunn at Cranfield University in 2007). Thereby, it would be extremely interesting if future research could start to envision and consider such aesthetical smart customizable products on smart customization offers.

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Article I. Smart Customization an Alternative to Mass Customization?

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Article II - Conceptualizing Smart User Toolkits for Co-design in Accordance with Customer Preferences

Abstract. *Smart customization is predicted to be widespread across various industries in the next decades. In the forthcoming era of the industry 4.0, customization is reinvigorating. That is, customers are likely to be more and more empowered with the emergence of what I call “smart user toolkits for co-design” to customize their purchased products. Compare to mass customization, the underlying idea, here, is to embed directly some user toolkits for co-design composed principally of data elements and software into consumer products. Thereby, a challenge that arises is to make these toolkits attractive enough so that a majority of customers selects them while preserving the functional aspects. So far, although literature has begun to address the importance of looking at the customer’s point of view on the user toolkits for co-design, little is known about the smart user toolkits for co-design presented in this paper. It is because of the fact that they currently are a few pioneering applications in the market place. Therefore, in this paper, I aim at understanding better the customer preference structure for smart user toolkits for co-design. By following this trajectory, I developed a choice based conjoint analysis on a smart user toolkit for co-design for mobile phones. The latter is an app that empowers customers to customize the features present in their mobile phone. In so doing, I first identified the features of smart user toolkits for co-design that significantly affect customer preferences; they are help functions, the visual aspects, the number of adaptable features and data privacy. Then, I showed dissimilarities in preferences depending on the consumer’s personal traits (i.e. preference variability, preference insight with perceived product customization and feature fatigue). Finally, with such findings, I contribute to theory by uncovering the extent to which a customer prefers some smart user toolkits for co-design in comparison with others. Beyond this, it allows me to add to the literature on user toolkits for co-design by conceptualizing further these toolkits characterized as smart in function of the customer preferences. Lastly, for producers, I propose them some judicious design tactics on smart user toolkits for co-design so that it fits better the target customer. Of course, at the end, I derive a set of propositions, which provides impetus for further research.*

Keywords: Smart Products, Customization, User Toolkits for Co-design, Customer Preferences

Introduction

Nowadays, both academics and practitioners announce new possibilities as the start of a new era in business (Bechtold, Kern, Lavenstein & Berhofer, 2014; Cook, 2008; Ernest-Jones, 2008; Prahalad & Ramaswamy, 2004; von Hippel, 2005). They believe that these possibilities are likely to happen thanks to the advance in communication and production technologies in the industry 4.0, which are: the increase in data volumes, the computational power and connectivity, the analytics and business-intelligence capabilities, the advances in human-machine interaction (Bechtold et al., 2014). With these technical changes, they foresee that, eventually, one of the possibilities is to put a “basic” principle of marketing into effect, namely giving customers exactly what they want (McKenna, 2002). In fact, in the last two decades, it is incontestably a challenge that firms have been taken up (Simonson, 2005; Thomke, 2016). They are currently taking advantages of such technological changes to propose customizable products that respond better and faster to each of the customer’s individual needs (Ernest-Jones, 2008).

Among several approaches that put this into effect, one is to integrate some smart user toolkits for co-design (smart UTCD) directly into consumer products so that they are turned into customizable ones. I call this approach “smart customization” in my research. The latter has recently emerged thanks to the recent applications of information and communication technology (ICT) in our products referred often as smart products in the related literature (Rijsdijk, 2006; Rijsdijk & Hultink, 2009). Briefly, a user toolkit for co-design is described as a set of complementary design tools that supports a layperson to customize a product via (1) a trial and error process and (2) a direct feedback on the creation outcome (von Hippel, 2001; von Hippel & Katz, 2002). To illustrate it, the Adidas One is a good example. The sneakers integrate in the midsoles a system with a smart UTCD consisting fundamentally of a user interface with buttons plus and minus, data elements, microprocessor and sensors. With these tools, it empowers users to customize directly the compression characteristics of the heel pads in function of the weight, activity, environment or running style. That is, users are given the opportunity to select some of the five gradient factory settings that will automatically adjust the hardness degree of the heel pads. Further, it is not an isolated case, products such as iPad, Wiz

or Lego Mindstorms belong to this new phenomenon. Clearly, they share all the singular capability, unlike mass customization, to assist customers to try out their various custom designs in a real usage situation until the optimal one is found (Gross & Antons, 2009). Besides, what is worth noting is that it is also beneficial for producers. By means of smart UTCD, they nowadays have the possibility to retrieve valuable data from their customers in the usage stage of their products, which permits them to optimize drastically their products (Thomke, 2016).

By having a look across various industries, it seems to be that smart customization is likely to be the future of customization. The claim is, in fact, fuelled by a wide-ranging survey of 600 senior executives from 20 industries that shows that fully 70% of them worldwide predicted that their main products (or services) will be fully or mostly customizable over the next years (Ernest-Jones, 2008). These executives, notably, believe that it should be easily applicable due to the recent differentiation of products through data elements and software rather than tangible elements. This is not surprising, given that such customization approach is already applied in product domains like multimedia (as one could easily forecast it) i.e. the iPad or Tasker but also toys like the Lego Mindstorms (mindstorms.lego.com), sport equipment with the Adidas One (e.g., adidas.com), houses i.e. connected lighting system (e.g., wiz.world) and car dashboard (e.g., Piller, Ihl & Steiner, 2010).

Yet, while in the business press, customer empowerment – one being with smart UTCD – is perceived as an opportunity to be tapped (see, e.g., Bechtold et al., 2014; Ernest-Jones, 2008), in contrast, the associated research is still scarce (Gross & Antons, 2009; Hermans, 2014; Thomke, 2016). Despite some early work realised by von Hippel and his collaborators on the concept of user toolkits for co-design (Thomke & von Hippel, 2002; von Hippel, 2001; von Hippel & Katz, 2002), this research is still described as emerging (Thomke, 2016). Moreover, this reveals to be particularly true for smart UTCD. They were introduced for the first time in the seminal work of Gross & Antons (2009) so as later on Hermans (2014), who both presented the notion of empowering a layperson to co-design directly their ordinary products. Yet, based on Ihl (2009), it would be of high interest to continue further in this research and, especially, extremely valuable, as a next step in this research, to identify the factors of customer-based success of such novel customization offers. Of course, the literature that addressed it in mass

customization can serve as solid groundwork (see, e.g., Dellaert & Dabholkar, 2009; Dellaert & Stremersch, 2005; Ihl, 2009; Randall, Terwiesch & Ulrich, 2005). However, it is important to stress the fact that this approach is associated to the pursue of a different firm's strategy than the one presented in this paper. That is, mass customization is a process that assists customers to create virtually their custom designs with some UTCD made available on the firm's website, which are then retrieved, produced and delivered to them (Pine, 1993). Hence, the customization process is different in comparison with smart customization.

Additionally, in this paper, the aim is, as well, to help firms gain a better understanding on how they can exploit fully the opportunities that come along with smart UTCD by preventing them from certain risks linked to the customer's perspective on these new tools. That is, a risk is that firms may fail to provide smart UTCD that attract enough the target customer. Commonly, all firms try to create successful products but, until now, they made only educated guesses on how best to appeal to their customers with smart UTCD (Ernest-Jones, 2008). In this regard, marketing literature on mass customization can be of interest (see, e.g., Dellaert & Dabholkar, 2009; Dellaert & Stremersch, 2005). It has, for instance, begun to address empirically the importance of understanding what may or may not attract consumers in various mass customization formats. Further, there is, also, a risk that customers may not be competent enough to appreciate customization. The problem is, as stated by Nisbett & Wilson (1977), that customers often fail to recognize a product that fits them the best. Earlier research in consumer decision making, reinforces it by, notably, uncovering that customers have a lack of knowledge in many product domains, which in turn gives them poor insight into what they truly needs (e.g., Bettman, Luce & Payne, 1998; Loewenstein & Prelec, 1993). Syam, Krisnamurthy & Hess (2008) so as Kramer (2007) even go further by stating that customers often select products they eventually dislike because of their lacks of preference insight.

Altogether, based on the above sections, the objective of this paper is to determine the customer preferences in terms of smart UTCD's format, considering that some customers do not have well-defined preferences. The present research addresses this question by building on the consumer choice theory (McFadden, 1986), the previous marketing research on mass customization (see, e.g., Dellaert & Dabholkar, 2009; Dellaert & Stremersch, 2005) so as the

literature on the concept of UTCD (see, e.g., von Hippel, 2001; von Hippel & Katz, 2002). My central premise is that the customer's latent utility for a smart UTCD is affected by (1) its design elements (i.e. visual aspects, help functions, the number of adaptable features and data privacy) (2) the perceptions they have on the product they own (i.e. feature fatigue, perceived product customization) and (3) the personal traits they have as consumers (i.e. preference insight, preference variability) (e.g., Piller et al., 2010; Simonson, 2005). To test this theory, I realized a choice based conjoint analysis (CBCA) on a smart UTCD present in the market. It is the "Tasker", which is an app that empowers users to customize the features already present in their mobile phone. An important finding is that customers always prefer smart UTCD equipped with a high degree of visualization and help functions, regardless of the number of features i.e. paradox of choices (Schwartz, 2004). The finding is, notably, in line with the research on the concept of UTCD that advocates that help functions in a form of help desk, online tutorial or user community so as some high visual aspects are essentials to maximize the value of customization (see, e.g., Jeppesen, 2005; Randall et al., 2005). In this literature, it is stated that these features are necessary to fill any significant gap regarding the competences required to use effectively UTCD. Hence, this finding suggests already that it is likely to obtain attractive and effective smart UTCD.

Of course, this study offers, additionally, theoretical and managerial contributions. On the theoretical side, this paper adds to our limited understanding on the customer preferences regarding smart UTCD' formats (Gross & Antons, 2009; Piller et al., 2010). Furthermore, it contributes to the construction of the theoretical and empirical foundations on tomorrow's products that are smart products (see, e.g., Rijdsdijk & Hultink, 2009; Thomke, 2016). On the managerial side, my findings clearly provide to firms some guidelines as to how to better target customer preferences and needs with smart customization offers. If successful (i.e. customer customize their product with a closer preference fit), they are likely to be rewarded with a higher customer loyalty, which in turn should generate, as posit by Peppers & Rogers (1997, p. 177) an "insurmountable barrier to competition, for one individual customer at a time".

Conceptual Framework and Research Hypotheses

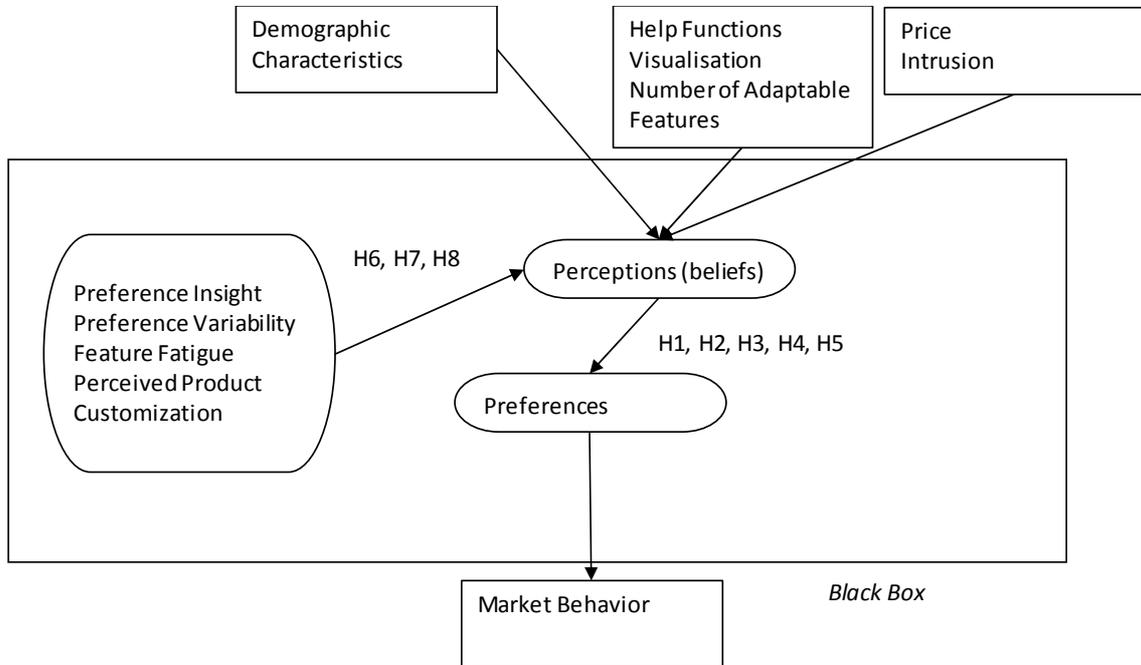


Figure. 2.1. Impact of the Consumer Perceptions on their Preferences (Own Representation Based on McFadden (1986))

The proposed conceptual model is presented in Figure 2.1. The figure portrays a model of the (cognitive) choice process of customers with the underlying idea that not all is observable in the black box. This is based on the original model of McFadden (1986) and Rao (2014). In this model, perceptions are influenced by the smart UTCD’ attributes and by thoroughly selected latent variables related to the customer’s personal traits. Then, perceptions influence preferences, the latter being determined by the utility of the smart UTCD. This model is obviously applicable to the stated choice data collected in this choice based conjoint analysis. Notably, with the analysis, it should permit to understand the respondent’s preference structure for a smart UTCD so as predict the “market” behaviour. Moreover, it is important to underline that the model is developed in line with previous marketing research studies on product customization so as with the literature on the discrete choice model (Dellaert & Dhabolkar, 2009; Dellaert & Stremersch, 2005; Ihl, 2009). More precisely, it is purposely built with the

discrete choice and latent variables approach used in the marketing literature and suggested by Mc Fadden (1986), Ben-Akiva & Boccara (1995), and more recently by Ashok, Dillon & Yuan (2002) so as Ihl (2009).

In general, in these studies, it is common to have, besides the product features, the demographic characteristics of the decision maker as influence factors (Mc Fadden, 1986). Yet, in this paper, it is different, inspired by the study of Dellaert & Dabholkar (2009), the model incorporates latent variables related to the customer's personal traits. The reason is, based firstly on Dabholkar & Bagozzi (2002), that the differences of choice related to the factors linked to personal traits are greater than with demographic factors as it is the core of behavioural intentions. Therefore, I selected established personal traits drawn from a variety of discussion in mass customization (e.g., Guilabert, 2005; Hoeffler & Ariely, 1999; Piller et al., 2010; Simonson, 2005). In addition, a recent study shows they are antecedent factors in the user acceptance of smart UTCD (Piller et al, 2010). To name them, these factors are preference variability, preference insight linked to perceived product customization so as feature fatigue. In this study, *preference variability* defines customers who view themselves as not having stable, well-defined preferences. In contrast, *preference insight* describes customers who believe they know exactly what their needs are in a given product domain (Simonson, 2005). Regarding the two last constructs, they capture the perceptions consumers have on the product they own. That is, *perceived product customization* represents customers - in the study only customers with preference insight due to the study of Piller et al. (2010) - who possess a customized product prior to the smart UTCD' integration (Guilabert, 2005), while *feature fatigue* depicts customers who feel too overwhelmed by the number of features they have to handle (Thompson, Hamiton & Rust, 2005).

Regarding the observable factors, all of them were extracted from the traditional literature on UTCD and grouped according to three main attributes, that are, help functions, visualization and the number of adaptable features (see, e.g., Dellaert & Stremersch, 2005; Jeppesen, 2005; Randall et al., 2005). Finally, fundamental to the reliability and validity of the model, price and data privacy were factored into the model. While price is often used as a control variable (see, e.g., Dellaert & Dabholkar, 2009), data privacy is deemed to be relevant in the light of the

public concerns on that subject matter (see, e.g., Caudill & Murphy, 2000; Goodwin, 1991; Martin, Borah & Palmatier 2017; Milne, 2000).

Impact of the Toolkit's Design Features on the Customer Preferences

Below are explained further the three attributes (or design features) of smart UTCD employed in the study and how they play a role in the functional benefit i.e. to assist adequately the customers in the customization process so that they obtain their ideal products.

Visualization. A high degree of visualization is an important design aspect to consider so that customers perform well with UTCD (Randall et al., 2005). As such, referring to Van der Heijden (2004), visual aspects are here to encourage users to prolong their uses and subsequently increase the probability they acquire their ideal custom design. In particular, von Hippel & Katz (2002) stress the fact that it is essential to propose UTCD with a user-friendly interface and an immediate visual product feedback of the custom designs. Since customers develop their optimal design via a process of “learning by doing”, with these visual aspects, customers can exclusively focus on acquiring information of all combinations available so as test some of them until they obtain the ultimate solution (Franke & Hader, 2014). In a learning process that is visual, customers can indeed uncover and define with easiness and intuition what they exactly want (Wind & Rangaswamy, 2001). Moreover, visualization increases the hedonic nature of UTCD, which appears necessary for these customization offers (Van der Heijden, 2004). In the study of Franke & Hader (2014), it is, for instance, showed that, when playing around with UTCD, customers increase the probability of getting their product right.

Number of Adaptable Features Available. In the design of UTCD, firms are the ones which decide which features should be customized and to what extent (von Hippel & Katz, 2002). The objective is always to include a library of modules (or combination of features) which results in a solution space that encompasses what customers want without making them feel overwhelmed (Abdelkafi, 2008). By applying this rule, it means, in practice, that certain firms propose a rather large solution space, often made available by combining relatively basic and general-purpose building blocks and operations i.e. Lego Mindstorms while others prefer a

small solution space with a relatively few specific “options” i.e. ADIDAS One (Prügl & Schreier, 2006). The challenge, for all of them, is, however, to find the right solution space that suits every customers (Piller, 2005). In particular, with a large solution space, the problem is that some customers may not be able to handle the number of possible combinations available, given that the capacity of a human being to process information is limited (Franke & Piller, 2004; Miller, 1956). Yet, with a small solution space, there is still an inherent risk that customers may not find what they want (Franke, Schreier & Kaiser, 2010).

Help Functions. While it is relatively easy to implement UTCD, some researchers argue that it is unlikely that customers possess the right skills to respond effectively to the possibility to customize their product (see, e.g., Franke & von Hippel, 2003; Jeppesen, 2005). It is particularly true for UTCD with a rather large solution space such as the Lego Mindstorms. Thereby, referring to Jeppesen (2005), help functions in a form of user communities, user-to-user assistance are fundamental to assist customers who have a lack of “design” skills in the customization process. Similar results are found in a study on the user-to user assistance realised by Lakhani & von Hippel (2003). In the marketing literature such as Alba, Lynch, Weitz, Janiszewski, Lutz, Sawyer & Wood, (1997) and Simonson (2005), it is different. They all showed that individual recommendations are, from time to time, essential to guide customers in the decision-making process of a feature. Reflecting the reality of customization offers, Randall et al. (2005) suggest, for instance, a help function in a form of a button “help me decide” like IBM did it to assist users in the selection of a specific feature. If one thinks about it, this is, in fact, comparable to the traditional purchase with sales representatives of products (Crosby, Evans & Cowles, 1990; Lee, Barua & Whintson, 2000).

Effects of the User Toolkit’s Design Features on its Utility

Effect of the User Toolkit vs No Toolkit. Franke & Reisinger (2002) uncovered via a broad survey of top tier journals that a considerable number of heterogeneous needs are left entirely unserved with standard products. Relying upon a sample of 15 studies, they found out that the average number of clusters in a market segmentation study to be 5.5, and the average remaining

within-cluster variance to be 46%. Franke & von Hippel (2003) found similar results in a preliminary study. Moreover, a complementary study showed that more and more customers prefer products they can customize to meet their own unique tastes and needs rather than the standard versions (Pine et al., 1995). Based on the above aspects, it means that customers are likely to rather select a smart UTCD than not having one in various product domains.

***Hypothesis 1.** Proposing smart UTCD to customers to customize their ordinary product as a higher utility than not proposing one.*

Effect of Visualization. Prior research in the marketing literature established that customers select a product not uniquely because of utilitarian reason but also hedonic. A body of research, notably, demonstrated that visualization is the main element to consider for the hedonic nature of a product (see, e.g., Babin, Darden & Griffin, 1994; Fiore, Jin & Kim, 2005; Hirschman & Holbrook, 1982; Holt, 1995). Van der Heijden (2004), in particular, posits, focusing on information systems – smart UTCD being one of them - that customers are likely to select these systems with a rather hedonic nature i.e. via high visual aspects. The latter is also in line with the literature on value creation that repeatedly demonstrated that the value of UTCD is not only utilitarian but also related to the enjoyment likely to be derived from using the tools (see, e.g., Franke & Schreier, 2010; Franke et al., 2010; Schreier, 2006). Therefore, when it is about visualization, smart UTCD are likely to be presented in some ways where the key element is a high degree of visualization.

***Hypothesis 2.** A high degree of visualization is likely to have a positive effect on the smart UTCD' utility.*

Effect of the Number of Adaptable Features. In general, customers enjoy having the flexibility to make their own choices (Deci & Ryan, 1985). Notably, they frequently select products or offerings with a high number of options (Botti & Iyengar, 2006). For instance, when having to decide between two ice cream places, one proposing a few flavors and the other plenty, they are likely to select the second one. The reason is, in their minds, more choices make them happier (Schwartz, 2004). It is also reinforced by some studies with mass customization

offers, which showed that UTCD with a higher range of adaptable features have a higher utility (Dellaert & Dhabolkar, 2009). Therefore, similar results are likely to be found with smart UTCD.

Hypothesis 3. A higher range of adaptable features is likely to have a positive effect on the smart UTCD' utility.

Effect of the Help Functions. Help functions are established to be some highly important features for the customers in the customization offers (Dellaert & Dhabolkar, 2009; Ihl, 2009). Given that they know they are likely to not have the right competences to customize; they perceive help functions as helpful. That is, they realize that help functions are likely to serve them greatly at the usage stage of UTCD (Simonson, 2005). Dellaert & Dhabolkar (2009) also demonstrated this in their empirical study, which shows that providing a help function drastically enhances the value of UTCD as it contributes to increase the customer's perception of enjoyment so as the product outcome and control. Additionally, the literature on customization is in accordance with the general research on ordinary products, which revealed that help functions are always positively received by customers as observed with common products (see, e.g., Childers, Carr, Peck & Carson, 2001; Crosby et al., 1990). Altogether, it means help functions are likely to increase the utility of smart UTCD.

Hypothesis 4. Help functions are likely to have a positive effect on the smart UTCD' utility.

Effect of the Intrusion Related Toolkit Characteristic. Greater intrusiveness is more and more likely to be an important attribute with the emergence of the digital world (Ernest - Jones, 2008). That is, with the proliferation of data elements and software within products, firms are given the opportunity of holding volumes of highly valuable, detailed, readily accessible information on their customers. It is notably, feasible with smart UTCD, where the idea is to retrieve user data at the usage stage of their product (see, e.g., Piller et al., 2010; Rangaswamy & Pal, 2003). In so doing, via this method, the shared notion is to adjust UTCD to an individual at a time (see, e.g., Randall et al., 2005; Wang & Tseng, 2014). But, in the meantime, the issue

of intrusion is growing in importance (see, e.g., Caudill & Murphy, 2000; Martin et al., 2017; Milne, 2000). The principal problematic is how transparent a company needs to be towards their customers and how far users are willing to forget their privacy rights (Ernest-Jones, 2008). Currently, one thing is sure customers do not want their personal data to be exploited without their full awareness (Milne, 2000). Therefore, it is likely that smart UTCD' utility is negatively affected by intrusion related factors.

Hypothesis 5. Intrusion related factors are likely to have a negative effect on the smart UTCD' utility.

Moderating Effects of the Factors Related to Personal Traits

Effect of the Preference Variability. Customers with preference variability represent a group of customers who do not have stable, well-defined preferences (Simonson, 2005). These customers are in majority in many product domains (Bettman et al., 2008). Such claim is reinforced by a great deal of evidence, which showed the customer preferences are not revealed but constructed overtime when interacting with products (for review see, e.g., Bettman et al., 1998; Fischhoff, 1991; Slovic, 1995). Furthermore, because they do not know what their preferences are, they are likely to evaluate UTCD in function of the degree of attractiveness rather than the fit (Bettman et al., 1998). In addition, they are likely to be highly receptive to help functions as they immediately recognize their ignorance in a given product domain (Simonson, 2005). One can easily understand it with the examples of the wine tasters. The ones who lack knowledge in this domain are clearly open to guidance so that they can select wines that are best for them (Simonson, 2005). Finally, about the number of adaptable features, the assumption of Schwarz (2004) holds in this context. That is the more options, the happier these customers are. Botti & Iyengar (2006) and Kahn & Wansink (2004), in fact, demonstrated that a large variety of options within products increases the perception of fun, which is sought by customers with preference variability. Therefore, these customers are likely to select smart UTCD with a high number of adaptable features.

***Hypothesis 6.** The moderating effect of preference variability on the relationships between the (a) visualization, (b) help functions, (c) the number of adaptable features and smart UTCD' utility is likely to strengthen them.*

Effect of the Perceived Product Customization. Perceived product customization defines customers who already possess a customized product in the tested product category (Guilabert, 2005). Referring to Piller et al. (2010), they are potential customers of UTCD. An interpretation of these authors is that UTCD are of high value for these customers to customize further and better their product. Moreover, such consumers are likely to have insight into their preferences so as an expertise in a defined product domain, given they have spent time customizing (Piller et al., 2010). Therefore, they are likely to not need help functions and so to perceive them as of no use (Hoeffler & Ariely, 1999). In addition, when having to decide for UTCD, they are likely to choose the ones with less visual aspects as, according to Lurie & Mason (2007), such they often hide useful data and information. Concerning the number of adaptable features, customers with perceived product customization are likely to select UTCD with a high number of adaptable features as it simply enables them to have a larger solution space – easily operated by them – more likely to include their ideal design or solution (Hoch, Bradlow & Wansink, 1999).

***Hypothesis 7.** The moderating effect of perceive product customization on the relationships between the (a) visualization, (b) the help functions, and the utility of the smart UTCD is likely to weaken them but the relationship between (c) the number of adaptable features and the smart UTCD' utility is likely to strengthen it.*

Effect of Feature Fatigue. A growing number of features are present in our products, especially, for smart products like the mobile phone, multifunctional kitchen robot, electronic watches (Poole & Simon, 1997). Often, on the shelves, customers perceive each one of these features as relevant, that is, in theory, they have a product with many capabilities at hand (Thompson et al., 2005). However, after purchase, most customers often feel overwhelmed by a too much of features, what Thompson et al. (2005) define as feature fatigue in their paper.

That is, customers feel submerged by the high number of features they have to handle in their products and are simply not capable of mastering too many (Den Buurman, 1997). Thereby, when having this sensation in the product they own, customers are likely to prefer not to have UTCD with too many adaptable features, perceiving them as adding intricacy (Dellaert & Dhabolkar, 2009). In contrast, they are likely to opt for UTCD with some visual aspects, as it is likely to permit them to understand easily information without feeling defeated (Lurie & Mason, 2007). In detail, the visual aspects are likely to increase problem-solving capabilities by allowing the processing of more data at once. Finally, about the help functions, referring to Steiner (2006), customers with feature fatigue are likely to perceive help functions as some additional features to manage on top of the others, meaning, they are likely to increase the feature fatigue of these customers.

***Hypothesis 8.** The moderating effect of feature fatigue on the relationship between the (a) visualization and the smart UTCD' utility is likely to strengthen it but the relationships between (b) the help functions, (c) the number of adaptable features, and the utility of the smart UTCD is likely to weaken them.*

Data and Method

Empirical Settings

A choice based conjoint analysis study is conducted to test the hypotheses developed in the previous section. In the interest of generalizing the results across various product categories, the empirical setting is selected within the following product domain: mobile phone. It is chosen as it belongs to an industry, which reaches all consumers; the mobile phone is nowadays a familiar object to all of us. Furthermore, it is a product that is often employed as a platform for diverse smart UTCD such as Wiz connected light, Tasker (see, e.g., Jeppesen, 2005; Piller, Fuller & Stotko, 2004; Prüggl & Schreier, 2006). Further, for realism, the Tasker was chosen as empirical setting. It is an app that empowers customers to combine the features present in their phones like call function, alarm clock or navigation systems in order to create new ones that exactly suit their individual needs. For instance, by connecting the navigation system, the pop up notifications, the agenda and the alarm clock, the phone's features can be customized with the Tasker to calculate automatically the required transit time from the user's position to the meeting's place and inform him/her via pop up notification when it is time to go. Plus, the navigation system can also be combined to the latter to launch automatically the right destination prior to departure. In in this regard, it is how the Tasker was scenarized in the study. Scenarization is quite common for "concept" testing (e.g., Dabholkar, 1996). Explicitly, I firstly conducted a focus group with students. They were asked to list all imaginable customizable options of the Tasker. Following this, I gathered all the options that refer to an identic and main subsystem of the phone. From it, a few scenarios were finally selected and retested on students in order to make sure of the clarity and relevance. At the end, it consisted of a 2 minutes' doodle video integrating the scenarios. That is, the video showed a sequence of scenarios that should provide respondents with an overview of the Tasker and its potential uses (see Appendix 1).

Data Sample

For the study, panelists were selected in the relevant product category i.e. only those who possess an android phone. The latter ensures me that subjects were familiar with the product

domain. Concerning the designated sample, an online research company elaborated it from a pool of android phone users in return for financial incentives. The panel finally consisted of 250 respondents who varied in gender, age, educational level and income level. Below is the structure:

- Gender quota: male (49%), female (51%)
- Age quota: 18-24 years (18%), 25-34 years (21%), 35-44 years (21%), 45-54 years (23%), 55-65 years (18%)
- Education quota: low (46%), middle (28%), high (26%)
- Income quota: 44% low (up to 39.999 \$), 25% middle (40.000 - 69.999 \$), 31% high (more than 70.000 \$)

The questionnaire was administrated online.

Procedure

The hypotheses were tested using an experimental design. After seeing the two minutes' doodle video, respondents were shown a set of two full profile stimuli and asked for a judgement as to which stimulus of the two or none they prefer. This choice set was, however, only a practice prior to starting with the real task. At the same time, they were as well provided with written instructions on how to do the exercise within the survey so as with some detailed information on the variables manipulated across the choice sets. Such introduction is a requisite in the conjoint analysis studies (Elrod, Louviere & Davey 1992; Verma, Thompson & Louviere, 1999). Actually, the practice test identical in structure to the actual choice sets is essential so that it reduces mistakes in the data, the objective being to familiarize the sample with the task. After having done the practice test, panelists were finally asked to go through the seven choice sets in which the various features of smart UTCd were manipulated. Altogether, four versions of seven pairs of full profile stimuli were utilized. In so doing, this customary procedure made it possible to capture data about the consumer's choice for smart UTCd. Finally, respondents were solicited to evaluate the product they own i.e. their mobile phone in terms of feature fatigue and perceived product customization and, in the last section of the questionnaire, asked to answer to questions on their personal traits as consumers of customization offers i.e.

preference insight and preference variability. Besides that, it is, of course, common practice to ask panelists to disclose personal information i.e. their age, their income, their educational level and their gender, which was realised in the study at the end of the survey. Appendix 2 and 4 provide further detailed information on the procedure i.e. choice sets and experimental design.

Experimental Manipulation

Factors and levels that were tested across the choice sets, all relevant and realistic, cover design aspects of smart UTCD related to one of the following attributes: the number of adaptable features, visualization or the help functions. In detail, extent of the customization of the phone with the Tasker was represented by the following number of adaptable features: 5, 10, 15 and 20. This is representative of UTCD in the market (see, e.g., Dellaert & Dhabolkar, 2009). About the visual aspects, they were manipulated by the availability or not of a visual trial and error simulation, by the accessibility of the Tasker via the mobile phone or via the mobile phone and PC so as by the presence of an interface which is either graphical via drag and drop or programming and coding. Finally, the help functions were tested by varying the types of representative help functions of smart UTCD, meaning, user community, online tutorial and help desk.

Further, some rather traditional aspects of products associated to the intrusion and price were incorporated into the stimuli. It is because of their current importance in the customer's choice process of smart products (Martin et al., 2017). In this regard, intrusion was manipulated by the availability of data privacy (yes, no) so as by the presence of advertisements (yes, no). Finally, the effect of price was captured through four levels, that are, Free /0,99 USD/2,99 USD/4,99 USD. This range of price is a good representation of what smart UTCD cost on the market (Dellaert & Dabholkar, 2009). Table 2.1 summarizes the factors and associated levels manipulated across the choice sets.

Table 2.1. Features Manipulated in the Scenarios

ATTRIBUTE		LEVEL	DESCRIPTION
VISUALIZATION	User Interface Software	Programming, Coding / Graphic with Drag and Drop	Degree of user friendliness of the user interface
	User Interface Hardware	Available on Mobile Phone and PC / Uniquely Available on Mobile Phone	Ability to employ the tasker software via different platforms
	Trial and Error Simulation	Available / not Available	Ability or not to have a direct visual representation of the feedback outcome
HELP FUNCTIONS	Online User Community Individual Supports	Available / not Available	Ability or not to have a user community
		None / Online Tutorial / Online Help Desk / Online Tutorial and Help Desk	Ability to have a direct online contact with the help desk or/ and to have online tutorial
NUMBER OF ADAPTABLE FEATURES	Number of Adaptable Features proposed	5, 10, 15, 20	Total number of features available to customize
INTRUSION RELATED FACTOR	Data Privacy	Available / not Available	Firm policy related to data privacy
	Advertisement	Available / not Available	Firm policy regarding proposing advertisement
PRICE		Free / 0.99 USD / 2.99 USD / 4.99 USD	Range of realistic prices proposed for such app on the app stores

Experimental Design

About the experimental design, a fractional factorial design of 56 profiles was used. Such procedure permitted to estimate all main effects in the proposed model as all factors were manipulated independently. Explicitly, the design is a 56-profiles fraction of a $2^6 \times 4^2 \times 3$ full fractional by which six of the attributes vary at two levels each, two at four levels and one at three. Subsequently, while 3072 combinations were possible, only 56 were necessary to estimate the model (Louviere, Hensher & Swait, 2001). Accordingly, as the choice sets consist of a pair of full profile stimuli with an option to pick none of the two, there were finally 28 pairs of full profile divided into four versions of the questionnaire. Concerning the order, it was

randomized for each version and panelists assigned arbitrarily to one of the four. That is, each panelist evaluated one version of seven pairs of full profile stimuli to yield a total of 304 observations.

Measurement Instrument

All four constructs in the model namely feature fatigue, perceive product customization, preference insight and preference variability were operationalized as often as possible using validated items from the relevant literature. Further details of the measurement scales that are not presented below can be found in the Appendix 3 of this dissertation.

Feature fatigue. This construct was measured from the items used by Piller et al. (2010). They were used as follow in this paper “It is easy to get [my mobile phone] and all its features to do what I want them to do”; “[my mobile phone] contains too many irrelevant features that are not of interest to me”; “Many features of [my mobile phone] are basically useless to me”; “Using certain features of [my mobile phone] is often difficult and exhausting” (1= “strongly disagree”, and 7= “strongly agree” ; Cronbach $\alpha = .84$).

Perceived product customization. Four items were used from Piller et al. (2010) to measure the construct. The ones elaborated by Guilabert (2005) in fact, inspire them. The items are: “For [my mobile phone] I chose an individual combination of features”; “When buying [my mobile phone], I paid special attention to certain features that meet my preferences”; “I try to customize [my mobile phone], so that it would exactly fulfil my individual needs”; “[my mobile phone] is almost identical and unaltered compared to the standard or base model” (1= “strongly disagree”, and 7= “strongly agree”; Cronbach $\alpha = .88$).

Preference insight. Preference insight was measured by means of three items used previously by Piller et al. (2010) and was adapted from Kramer (2007) and Simonson (2005). Finally, the items were used as follow: “Regarding [my mobile phone], I know exactly what I want”; “When I purchase [my mobile phone], I usually know quite soon what I prefer”; “When I purchase [my mobile phone], I find it easy to choose among different alternatives”. The scale is anchored “strongly disagree – strongly agree” on seven points Likert scale; Cronbach $\alpha = .90$.

Preference variability. Items taken to measure the construct are from Piller et al. (2010) and formulated beforehand by Simonson (2005). They are red as follow in the study: “My preference concerning [my mobile phone] features and characteristics constantly change”; “I often have changing or even new requirements for [my mobile phone]” (1= “strongly disagree”, and 7= “strongly agree”; Cronbach $\alpha = .86$).

Obviously, a pre-test of the measurement scales was conducted targeting academics and non-academics to ensure that the scales were adapted and understood rightly within the defined context. Some wording changes were realised right after.

Finally, with the collected data, exploratory and confirmatory factor analyses were undertaken to examine the reliability and validity of these constructs (see Article 1)

Analytical Model

Customer preferences for smart UTCD were modelled using consumer choice theory as a basic framework (McFadden, 1986). The general idea of the theory is that a participating consumer makes a choice from a set of alternatives in the way that his/her utility is maximized. In other words, the utility of smart UTCD that the individual chose U_{iutt} should be the highest among the utility U_{iot} of all the other considered alternatives (o). Accordingly, the probability $P_i(ut_t)$ that consumer i chooses a smart toolkit ut in a scenario t is expressed as:

$$P_i(ut_t) = P(U_{iutt} > U_{iot}) \quad (1)$$

So, under this premise, the modelling approach is first to understand that the utility U_{iutt} of a smart UTCD consists of two elements: a deterministic and a random one. The deterministic element which is measured via the systematic utility V_{iutt} that consumer i gets from a user toolkit ut in scenario t, is modelled in function of the observable factors (the one factor here being the observable toolkit’s features but it could be additionally the observable user characteristics). Regarding the random element, it is basically the specific error term ε_{iutt} that captures the unexplained variation in consumer preferences because of the measurement error and unobserved explanatory variables (such as an unobserved idiosyncrasies of tastes). So, altogether, the utility U_{iutt} of a user toolkit can be expressed first as:

$$U_{iutt} = V_{iutt} + \varepsilon_{iutt}. \quad (2)$$

Then, as mentioned earlier, the systematic utility can be decomposed as a function of the vector of features \mathbf{X}_{iutt} of the user toolkit. Furthermore, α_{iut} , which is an individual specific random intercept, is also added to the equation in order to capture unobserved heterogeneity of the respondents. Notably, it permits to justify panel-like data with repeated observations per individual. Besides, all error components, meaning α_{iut} and ε_{iutt} are assumed to be independently normally distributed. Following this, the utility U_{iutt} is further expressed as:

$$U_{iutt} = \alpha_{iut} + \beta\mathbf{X}_{iutt} + \varepsilon_{iutt}. \quad (3)$$

Next to it, it is important to express the utility for an individual i of obtaining the product of interest via a best viable alternative way. It is defined as follow: $U_{iot} = \alpha_{io} + \varepsilon_{iot}$ where α_{io} is an individual specific constant and ε_{iot} is the related error component. Then, the binary random coefficients logit model is acquired by normalizing α_{io} to zero for identification and presuming that the error components ε_{iutt} and ε_{iot} are independently and identically Gumbel distributed (e.g., Wooldridge, 2002). Finally, this model allows for testing the effect of the user toolkit' attributes on its utility. It is estimated by simulating maximum likelihood (Train, 2003).

Additionally, a vector of observable user characteristics \mathbf{Z}_i (gender, age, income, etc.) can be added to the equation so that one can further explain the observed characteristics of the decision makers onto choice behavior:

$$U_{iutt} = \alpha_{iut} + \beta\mathbf{X}_{iutt} + \gamma\mathbf{Z}_i + \varepsilon_{iutt} \quad (4)$$

This equation just leads to a conventional discrete model that simply permits to map observable smart UTCD' features and panelists characteristics onto choice behavior (Ben-Akiva & Lerman, 1985). In this kind of models, the respondents' internal process of preference formation is treated as a "black box" because the latent factors related to consumers' attitudes and perceptions are not explicitly considered (McFadden, 1986). Thereby, by integrating such latent constructs into the discrete choice models, it should lead to a deeper understanding of the choice processes and a greater explanatory power. Here, that is what I further projected with the proposed model. Latent variables related to user personal traits were added into to the model. They all moderate the effects of observable smart UTCD' features. Then, in line with the

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econometric implementation, another type of variable is introduced into the utility function of the discrete choice model. It is a vector of the latent user personal traits ξ_i . Then the utility is finally expressed as follow:

$$U_{iutt} = \alpha_{iut} + \beta X_{iutt} + \gamma Z_i + \delta \xi_i + \varepsilon_{iutt} \quad (5)$$

In this regard, separate models are estimated for each smart UTCD' features. All error terms are assumed to be independently normally distributed.

Results

What is of great interest is that panelists receive choice sets that include a “none” option associated with a “utility value”. In so doing, the results show that respondents always select smart UTCD. Additionally, the findings indicate it is highly significant. It is evident by looking at the importance of the path worth estimates. An explanation is that customers rather select smart UTCD even though not attractive to them than not having some in their product. Such results are clearly in line with previous research on customization offers (see, e.g., Pine et al, 1995). H1 is then validated.

Further, the findings of the estimates that capture the main effects of product attributes at the scale of the levels (i.e. three attributes proper to smart UTCD and two that are common ones) on the overall utility of smart UTCD are summarized in Table 2.2. As one can observe, all three attributes (visualization, high number of adaptable features and help functions), as predicted, have significant positive effects - except for the instant test simulation - on the customer preference judgement for some Smart UTCD. Accordingly, the hypotheses H2, H3 and H4 are supported. Further, the two last attributes related to the more traditional aspects of products that are especially smart, namely intrusion (like providing advertisement so as collecting personal data) and price, have some significant negative effects on the overall utility of smart UTCD. Subsequently, hypothesis H5 is supported.

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Table 2.2. Conjoint Estimates

Attribute	Coefficient		Hypothesis	Standard Deviation	
	Parameter (Standard Error)			Parameter (Standard Error)	
No. of Adaptable Features	0,032 (0,012)	***	H ₃	0,120 (0,017)	***
User Interface Hardware	0,403 (0,115)	***	H ₂	0,542 (0,426)	
User Interface Software	0,411 (0,116)	***	H ₂	0,508 (0,233)	**
Instant Test Simulations	0,155 (0,109)		N.A	0,090 (0,197)	
Online Tutorials	0,394 (0,164)	**	H ₄	0,284 (0,257)	
User Help Desk	0,447 (0,174)	**	H ₄	0,196 (0,391)	
Tutorials and Help Desk	0,400 (0,142)	***	H ₄	0,138 (0,465)	
User Community	0,274 (0,105)	***	H ₄	0,029 (0,169)	
Advertisement	-0,779 (0,115)	***	H ₅	0,746 (0,173)	***
Privacy	1,430 (0,152)	***	H ₅	1,223 (0,171)	***
Price	-0,579 (0,056)	***		0,584 (0,059)	***
Constant	-1,488 (0,330)	***	H ₁	3,578 (0,305)	***
Number of Observations		304			
Parameters (k)		24			
Log Likelihood (1 Constant Only)		-2 311			
Log Likelihood (k)		-1 596			
Chi-square		1 428		***	
McFadden-R2		0,309			

Two Tailed t -Tests; * < 0.1, ** p < 0.05, *** p < 0.01

N.A. = Not Applicable

Furthermore, besides reporting the impacts of each level within an attribute that influence the formation of an overall preference, conjoint analysis permits also to assess the relative importance of each attribute. Thereby, I made use of it to explain how much supported my

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hypotheses are, that is, how much of an importance have the effects of each attribute in the decision-making process of a customer for smart UTCD. Results are presented in Table 2.3.

Table 2.3. Partial Effects

Attribute	Level Changed from	Level Changed to	Change in Market Share	Relative Importance
No. of Adaptable Features	5	20	0,70%	1,37%
User Interface Hardware	via mobile only	via mobile & computer	2,52%	4,90%
User Interface Software	some comand programming required	graphical interface with drag & drop	2,60%	5,07%
Instant Test Simulation	no	yes	1,02%	1,98%
Online Tutorials	none	online tutorials	2,61%	5,08%
Help Desk	none	help desk	2,97%	5,79%
User Community	no	yes	1,81%	3,53%
Advertisement	yes	no	5,41%	10,54%
Privacy	no	yes	8,95%	17,44%
Price	\$4.99	\$0.00	22,74%	44,31%
Overall	Worst Case	Best Case	49,08%	100,00%

By looking at these findings, it is evident that the most important attributes in the customer's decision-making process of smart UTCD are the traditional ones. Price is the first one with an importance of 44,31 per cent whereas intrusion (advertisement and privacy) is second with a total of 27,98 per cent. About the others related to the smart UTCD' characteristics, the most

important one - placed in the third position - are the help functions with a total of 14,40 per cent, followed closely by visualization, 11,95 per cent and finally by the number of adaptable features - far behind - which only has 1,37 per cent of an importance in the customer preference judgment for smart UTCD. The last result is, though, surprising, given that, with conjoint analysis, the higher the number of levels - so as it is the case with the number of adaptable features - the greater is the importance of the associated attribute (Rao, 2014, p.44). What is interesting with these results is that, when comparing with prior studies' findings on mass customization offers (see, e.g., Dellaert & Dabholkar, 2009; Randall et al., 2005), they are overall in line. For one thing, Dellaert & Dhabolkar (2009) already showed that visualization and help functions have a high impact on the cost-benefit perception of UTCD for mass customization, which in turn increases the customer acceptance. One difference, though, with the latter study so as compare to the current one is the ranking of the UTCD' attributes. Visualization is first, followed then by the help functions. In both studies, however, it is clear that the number of adaptable features is not relevant in the customer judgment as long as the right visualization and help functions are present. In addition, what is unexpected from Table 2.3, is that the ideal smart UTCD originated from the respondents data corresponds to the concept of UTCD developed two decades ago (see, e.g., von Hippel, 2001; von Hippel & Katz, 2002). Concerning the Chi square of 1 428, it is significant at the .01 level, which permits to conclude that panelists' choices are significantly affected by the various levels of factors.

In Table 2.4 below, is shown the estimation results for the model and a summary of the results. Above all, it presents the influences of the latent variables related to the customer's personal traits on the various attributes' utilities so as smart UTCD' one. As hypothesized, the null hypothesis is rejected for all hypotheses except for H7a and H8a. It means that the choice's process for smart UTCD differs with the customers' type. Further, my findings confirm that preference variability so as perceived product customization have significant positive effects on the basic utility (i.e. the "none" option has no utility for them). Moreover, my results reveal that, with respondents who do not have well-defined, stable preferences, the increase of the disutility for one-dollar price is significantly negative. It means these customers are not affected by an increase of one-dollar price. An interpretation is that they perceive UTCD of high value.

Table 2.4. Moderating Effects

Model	1	2	3	4	5	6
Dependent / Independent Variables	Basic Utility	Utility from Adaptable Features	Utility from Graphical Interface	Utility from Direct Help Desk	Utility from Privacy	Disutility from One-Dollar Price Increase
	Parameter (S.E.)	Parameter (S.E.)	Parameter (S.E.)	Parameter (S.E.)	Parameter (S.E.)	Parameter (S.E.)
<i>Mobile Phone</i>						
Customization	0,541 *** (0,197)	0,016 *** (0,005) H7c	0,003 (0,014) N.A. (H7a)	-0,009 ** (0,005) H7b	0,123 ** (0,054)	-0,012 (0,030)
Feature Fatigue	-0,076 (0,176)	-0,011 ** (0,005) H8c	-0,006 (0,012) N.A. (H8a)	-0,007 * (0,004) H8b	-0,029 (0,048)	0,019 (0,027)
<i>User Attributes</i>						
Preference Insight	-0,013 (0,183)	-0,005 (0,005)	0,004 (0,013)	-0,001 (0,004)	0,008 (0,050)	0,008 (0,028)
Preference Variability	0,495 ** (0,210)	0,011 ** (0,005) H6c	0,029 ** (0,015) H6a	0,009 * (0,005) H6b	-0,004 (0,058)	-0,082 ** (0,032)
<i>Demographics</i>						
Age	-0,015 (0,012)	0,000 (0,000)	0,002 *** (0,001)	0,000 (0,000)	0,004 (0,003)	0,001 (0,002)
Gender = Female Higher Education [yes]	-0,273 (0,331)	-0,005 (0,009)	0,046 ** (0,023)	-0,002 (0,008)	0,122 (0,091)	-0,046 (0,050)
Income [\$1,000]	0,031 (0,050)	-0,001 (0,001)	-0,005 (0,003)	0,002 (0,001)	0,017 (0,014)	-0,003 (0,008)
Constant	2,255 *** (0,726)	0,039 ** (0,019)	0,300 *** (0,050)	0,425 *** (0,017)	1,010 *** (0,199)	0,600 *** (0,110)
No. of Observations	304	304	304	304	304	304
No. of Parameters	9	9	9	9	9	9
F-test	F[8,295]= 5,031**	F[8,295]= 3,405***	F[8,295]= 1,918*	F[8,295]= 1,346	F[8,295]= 1,497	F[8,295]= 1,892*
R ²	0,120	0,085	0,049	0,035	0,039	

Zwei-seitige t -Tests; * < 0,1, ** p < 0,05, *** p < 0,01

N.A. = Not Applicable

Discussion and Further Research

In this research, one of the first result is that consumers rather select a smart UTCD than not having one. Thus, it confirms one more time that customization does have mass appeal among consumers so as uncovered in prior research by Pine et al. (1995) and Seybold (2001). Yet, it does not always result in a success for firms proposing these kinds of offers. In fact, while customers find these offers attractive, they often turn their backs on the firms that offer them once they experience that they are unable to customize a product with a closer preference fit (see, e.g., Bharadwaj, Naylor & Hofstede, 2009; Syam et al., 2008). As Bharadwaj et al. (2009) demonstrated most consumers who have low preference insight are simply incapable of creating a customized product that suits them. Therefore, they are less likely to go back to the same firms for future purchases, having been highly disappointed with the product outcome. Yet, in this paper, the focus is not on this type of customization offers but rather on a novel one “smart customization”, that makes use of the advent of smart UTCD. The latter has the singularity to enable consumers to customize their ordinary product in a real usage situation. In this regard, a new challenge arises, though, which is for firms to make smart UTCD attractive enough so that customers select them in the market place so as, at the same time, preserve the functional benefit of smart UTCD so that their users can customize successfully their product. So far, literature has only focused on the latter, meaning, the functional aspects of UTCD (Franke & Piller, 2003), which is not surprising given that most customization offers are not consumer products. Yet, the particularity of smart customization offers is that they consist of some smart UTCD integrated into consumer products i.e. Tasker, iPad, Adidas one. Thus, to succeed, firms have additionally, to consider how customers decide to select the key elements: smart UTCD. Thereby, the aim of this paper is to design and conceptualize further smart UTCD in accordance with the customer preferences.

As a general finding, certain smart UTCD' attributes i.e. the number of adaptable features, visualization and help functions reveal to play a major role in the customer preference structure. All three show significant effects in the customer's decision-making process for a smart UTCD. Help functions are the most important, followed closely by visualization. Regarding the number of adaptable features, even though it is significant, it has, surprisingly a minor effect. With these

findings, it suggests that if the right help functions and visualization were part of smart UTCD, they would be selected over others, regardless of the number of adaptable features that is available. Furthermore, my results reveal that help functions and visualization differ in function of the customer's personal traits. Interestingly, customers choose both features in the way that they will serve them greatly in the usage stage. Furthermore, it is exciting to observe that my findings are in line with the conceptual UTCD developed two decades ago by von Hippel (2001) and von Hippel & Katz (2002). That is, the authors showed that help functions are essential to assist customers to maximize the value of customization, while a high degree of visualization is necessary to guide them effortlessly towards the optimal solution. Further than that, it is established in a more recent literature that some aesthetical visual layouts permit, in addition, to emphasize the fun aspect of these customization offers, which is an important side effect of customization (Franke & Schreier, 2010; Schreier, 2006). About the number of adaptable features, my results tend to indicate that firms have to be the ones to decide about this design aspect independently from the customer's point of view. That is, they have to determine which features to customize so as their degree of customization (von Hippel & Katz, 2002). Additionally, in this regard, my findings seem to confirm the idea of providing an adaptive solution space for each customer, so as suggested in the literature by Tseng & Piller (2003), Blecker, Friedrich, Kaluza, Abdelkafi & Kreutler (2005) and more recently by Wang & Tseng (2014). As Randall et al. (2005) stated it is somehow confusing that, while customization offers are based on the evidence that individuals have heterogeneous needs, most of the time, only one standardized offer is proposed. Yet, until now, the truth is that customers have always had the option to try out and abandon if they are not satisfied with mass customization offers, but, with the smart customization ones, it is impossible, as they are purchased products, hence, the effect would be consequential. Most likely, customers would be extremely dissatisfied if the smart UTCD embedded in their products are not usable to guide them in the creation of their designs. However, with the retrieve of user data, it might be feasible to propose customers a smart and adaptive UTCD that suit their competences and preferences.

When looking at the results closely, it seems that the fact customers are likely to not be competent enough to customize or to select the right customization offer is not an issue. My

findings, indeed, indicate they are, at least, capable of selecting the right help functions that should assist and instruct them in the customization process. One thing, though, to consider is that, for certain customers who experience feature fatigue in the product they own, results confirm they definitely perceive help functions as adding some intricacy within the tool. It was also observed by Dellaert & Dhabolkar (2009) in their studies on mass customization offers i.e. they showed that customers with feature fatigue do not want to have help functions as additional features. Similar findings are uncovered for customers who possess already a customized product in the certain product domain, the reason being identical. Yet, what is the most important is the overall findings, which indicate that customers in general – most importantly the ones who do not have well-defined preferences – positively respond to all help functions. Hence, in other words, it means producers with the right help functions are perfectly able to support their target customers when they have a lack of innovative design skills, preference insight or even both. In this regard, the general notion is not to consider the development per se of the smart UTCD, but rather to focus entirely on the customization process with a target customer. In this regard, help functions can be used as follow i.e. some tutorials to teach users on how to create, user communities to help technically (Jeppesen, 2005) and help desks to define their preferences i.e. what IBM did with the button “help me decide” when customers are unable to take a decision for a certain feature.

Further, as seen in the results, visualization is the second factor important in smart UTCD’ design from the customer’s perspective. What is particularly interesting is that the effect of visualization on the overall utility of a smart UTCD is positively moderated by preference variability. The results suggest that, when having to decide for one smart UTCD, customers with preference variability are likely to select the one with a high degree of visualization. It is in coherence with the study realized by Babin et al. (1994) which revealed that these customers select a product via a principal criteria which is the visual aspects (i.e. which contribute to its hedonic nature) as they intend to use products just for the sake of having fun, not being capable of selecting them differently. Moreover, the high degree of visualization is known to make the process information easier (Franke & Hader, 2014; Van der Heijden, 2004). Thereby, getting

this feature right does not have only a positive effect on the customer adoption but, also, retention.

Additionally, my results reveal that the range of adaptable features influence the overall utility of smart UTCD. All findings – except for feature fatigue as predicted – indicate that all customers are likely to select smart UTCD with the highest number of adaptable features. It is just automatic and unconscious, as mentioned by Botti & Iyengar (2006), but customers always select the option with more choices. However, the findings reveal that this attribute is not essential in the preference structure of customers in comparison with the visualization and help functions. It is great, knowing that this feature could have been problematic. That is, with too many features to handle, users are confronted with the paradox of choices (Schwartz, 2004). As posit by the author, the more options, the easiest to regret on selecting an option. Hence, it results for users either to feel overwhelmed by the number of combinations at their disposal and unable to decide on which option is the best or unconvinced with the option they go for (Huffman & Kahn, 1998; Kamali & Iker, 2002; Wind & Rangaswamy, 2001; Zipkin, 2001). At the end, for these customers, the cost of actively designing may finally exceed the benefits of having a customized product, having users ending up being extremely dissatisfied with customization (Franke & Piller, 2004). Yet, despite a warning of this issue in the literature, there is barely research on tackling the problem (Piller, 2005). Notably the traditional literature on UTCD does not cover this aspect (Piller & Salvador, 2016). For the moment, while certain firms provide a limited choice not to overstrain customers, others prefer to propose an infinite number of combinations to make sure customers will find their ideal solution (Franke et al., 2010). Overall, it is a research aspect that can be addressed for future research on customization offers.

Finally, a great deal of evidence supports the idea that the more traditional aspects of products should be of concerns, that is, both price and intrusion are highly significant for customers. Notably, firms are given the opportunity with smart UTCD to collect data from their customers during their usage in order to improve their processes, objects or envision future customer trends. Yet, the results reveal that customers do not want their smart UTCD to be too intrusive i.e. in which advertisement is present and all confidential data collected without their

permissions. By interpreting the finding, it seems to be that a good solution would be, as it is essential for firms, to continue to collect user data, but to the extent of respecting privileged information from their customers (Ernest-Jones, 2008). So, some rules have to be established that strike a delicate balance between both. One thing is for certain, firms should be transparent with their customers concerning the use being made of their data (see, e.g., Milne, 2000). Yet, much remains to be realised in this new and challenging area of research (Martin et al., 2017). This is, of course, why the Marketing Science Institute (2016) listed it as one of the eleven research priorities from 2016 to 2018.

Furthermore, some findings unrelated to my study and limitations are worth mentioning and may suggest additional areas for further research. Notably, my results uncover that consumers with preference variability have a low-price sensitivity for smart UTCD, which usually indicate they attribute a high value for these tools. An interpretation of this finding is that they might be something for these customers like viewing this offer as “exclusive” (Franke & Piller, 2004). With smart customization offers, it may finally provide them the right settings to combine their enjoyment to customize due the “flow” experience (Ciszkoszmiyhalyi, 1996) and the pleasure of identifying their wants what other customization offers could not provide them (Simonson, 2005). Such outcome suggests that smart customization can become a mean for new profits opportunities. Alike mass customization (Franke & Piller, 2004), smart customization seems to follow the same path but for customers with preference variability. It can have strong implications for smart UTCD’ development i.e. proposing a “premium” smart UTCD for such specific customers. Further research in this matter might be worth pursuing.

Additionally, for future research, one might consider to develop further the theoretical framework used in the study and inspired by McFadden (1986). The author recommends to combine the discrete choice and latent factor modelling in order to describe better the customer’s decision making process. Nonetheless, as mentioned by the author not all is described in the black box of the framework. Accordingly, researchers have the possibility to investigate how certain attributes of UTCD are evaluated and mediated by more abstract, latent perceptions i.e. attitudinal or behavioural constructs that may be further interrelated before leading to the final consumer preference structure.

Besides, certain limitations can be derived from the CBCA study. First, panelists only made hypothetical choice via series of online scenarios i.e. it is a stated choice data rather than revealed choices. Although the study used a highly relevant and realistic group of respondents and paid great attention on reproducing real world profiles of smart UTCD, consumer's choice process can differ when faced with real products i.e. low external validity (Ihl, 2009). Thereby, it would be an idea to test the same hypotheses in a real-world purchase context (see, e.g., Dellaert & Dhabolkar, 2009). Second, some high visual sets of full profile stimuli would have been better. It is likely that it would have been easier for panelists to decide on a profile by enabling them to process more data at once. It is notably because of the slightly higher number of attributes than usual (see, e.g., Hair, Black, Babin, Anderson & Tatham, 1998, p. 428). Finally, whereas a sample of 250 panelists was used for this study, less than that were employed for constructs linked to the personal traits. It is a limitation that must be notified to the readers. Moreover, the article only focuses on smart UTCD that permit individuals to customize digitally their mobile phone i.e. to customize the features present in their mobiles phones. Yet, while such smart UTCD are growing in importance, it might be interesting to examine, due to the forecasted impact of additive manufacturing in tomorrow's industry (Berman, 2012; Weller, Kleer & Piller, 2015), whether these findings hold for UTCD of a 3D printer. In this regard, UTCD are no longer provided to empower users to create virtual outputs but rather tangible products. Thereby, there are observable differences such as the trial and error process. Thus, an idea would be to reproduce this study and compare the results.

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Article III – Interaction Patterns of Smart User Toolkits for Co-design with Customers for an Ultimate Solution

Abstract. *The recent applications of information and communication technology in consumer products unveiled a promising form of user-product interaction. Somehow, a handful succeeded to empower users to co-design their product for each use. These artefacts that make use of smart user toolkits for co-design share the capabilities to permit customers to adapt their product to a usage situation. One of the best pioneering applications is the iPad. Users co-design their iPad for each of their individual uses ranging from using it as a book, monitoring a medical device, to employing it as a cash register in shops. In this regard, it is evident that the value customers attach to this new class of products is less related to the performance of fulfilling a given task but rather to the capability of empowering them to adapt their product to the individual needs. So far, research on these products has mainly been focused on the technical aspects, yet, it appears essential to understand the mechanisms of co-design that occur between customers and smart user toolkits for co-design, given that some clearly fail to support successfully users in their pace to obtain the ideal solution. Further, by addressing this research aspect, it should also permit to provide firms interaction patterns of smart user toolkits for co-design. Reflecting the reality, these patterns are fuzzy and incomplete. By following this trajectory, I made use of the theoretical framework for use generation and applied it on the two types of smart user toolkits for co-design present in the market place (i.e. Adidas One and Lego Mindstorms). In so doing, it enabled me to expose the reasoning of co-design that occur in the interaction between the user and the smart toolkit, identify the nature of these mechanisms and so the associated difficulties. Furthermore, with the findings, I could provide firms some measures under which these mechanisms of co-design are more effective for the mass (i.e. to obtain the interaction patterns). Then, I finally propose a set of suggestions for further research on this promising topic.*

Keywords: Use Generative Goods, User Toolkits for Co-design, Smart Products, Design Theory, Co-creation with a Lay Person

Introduction

Nowadays, with the advent of products that integrate the information and communication technology (ICT), one could observe the emergence of “use generative goods” (Brown, 2013). They are described as having unknown uses prior to their launch on the market and as sharing the ability to encourage users to co-create uses i.e. iPhone, iPad. However, as shown by Brown (2013), their successes are still anecdotic, most of them being flops. Yet, they certainly open up some stimulating research avenues on the smartness and adaptability of the tomorrow’s products, which would eventually permit customers to adapt them to their individual needs (Ernest-Jones, 2008). Notably, with the forthcoming era of the industry 4.0, it is very likely to be happen (see, e.g., Baur & Wee, 2015; Bechtold, Kern, Lauenstein & Bernhofer, 2014; Ernest-Jones, 2008).

Among several promising ways, one of them applies the notion of customer co-creation, envisioned already in 1991 by Udvardia & Kumar, where the idea is that customers and firms are co-designers of those products fitting each of the customer’s individual uses. That is, the notion was applied it in the management domain by von Hippel (1994; 1998) to overcome the issue of the “sticky” information in the development process of a new product. The “sticky” information is defined in this literature as being customer needs related information not effortlessly transferable in the form usable from the consumer’s recipient to the firm’s one. Thereby, to solve this issue, von Hippel (2001) proposes to apply the concept of customer co-creation so that the “sticky” information related design task could be entirely shifted to customers. In practice, the idea is to equip customers with some user toolkits for co-design (UTCD) so that they are guided to transform their latent needs into a concrete solution or design (Piller & Salvador, 2016; von Hippel & Katz, 2002). That is, UTCD are sets of design tools that empower a layperson to co-design their ideal solution for an individual use via (1) a trial and error process and (2) a direct feedback of the creation outcomes (Franke & Piller, 2003; von Hippel, 2001; von Hippel & Katz, 2002).

Lately, with the progress of ICT, it is interesting to observe that UTCD have evolved and been modified into modern, high-tech products that can be directly integrated in consumer

products (Thomke, 2016). I call them “smart UTCD” in this article. In particular, in comparison with UTCD, smart UTCD have the distinctiveness to possess the right capacities to support customers in their efforts of co-designing. Their advantage is that they offer an iterative experimentation in a real usage situation of the customer’s diverse solutions (Gross & Antons, 2009; Hermans, 2014). In fact, various early adopters have already shown their value. With the proliferation of mobile phones and the increasing number of connected objects, smart UTCD are, for instance, nowadays, present in a form of an app connected with ordinary objects. A good illustration is the Wiz lighting system, which is a smart UTCD, where the idea is to give the possibility to customers to “co-design” the lighting of a house in one click by permitting them to control each connected bulb in terms of color, brightening, energy. Further, the smart UTCD can also allow to combine the bulb’s functionality with other connected objects i.e. Alexa. In so doing, it empowers users to “co-construct” individual experiences of uses such as being notified when there is a break in, creating an appealing atmosphere, or simply reducing the energy bill. In fact, industry experts believe that the maturity of smart UTCD should lead to their diffusion (Ernest-Jones, 2008). For instance, the Massachusetts Institute of Technology currently develops an intelligent house that permits users to customize it according to their needs (Rijsdijk & Hultink, 2009).

Yet, despite the business press’s enthusiasm for these smart products (Ernest-Jones, 2008), research in this field is still described as “emerging” (Thomke, 2016). The focus has always been focused on the technical aspects of UTCD and the production environment associated (Franke & Piller, 2003; Thomke, 2016). Notably, it is surprising that so little is known on the mechanisms (or reasonings) of co-design that occur between customers and UTCD, as co-creation can uniquely take place with the customer’s deep involvement in the co-design activities (Franke & Piller, 2003; Udwadia & Kumar, 1991). In fact, Franke & Piller (2003) go further by pointing out that it is rooted in our lack of means to expose these mechanisms of co-design, the current ones being unsuitable to comprehend them in details. However, reflecting the reality, more and more (smart) UTCD fail to engage customers in the co-design activities (Prügl & Schreier, 2006; Thomke, 2016). Franke & von Hippel (2003), for instance, show it remarkably with the Apache Software – which is a smart UTCD – where only 37% of

the customers felt they could create something. Thereby, following this, the aim of this paper is to address finally this challenging research topic and so fulfil this long-term research gap. I do so, by making use, for the first time in this literature of another stream of research, that is, the modern design theories (see, e.g., Hatchuel & Weil, 2003; 2009)

In details, by following this trajectory, I use the theoretical framework for use generation developed from the above-mentioned literature (Brown, 2013). That is, I applied it on the two types of smart UTCD described in the literature (Prügl & Schreier, 2006; von Hippel & Katz, 2002). In so doing, it permits me to expose the reasonings of co-design of uses that take place between customers and smart UTCD, identify the nature of the mechanisms of co-design carried out by smart UTCD and pinpoint the difficulties that occur from the customer's side. Finally, it, also, enables me to suggest firms measures in a form of additional services (i.e. for support and supervision) under which these mechanisms are more effective for the mass. So how I contribute to theory and practice? I finally open up the black box on the reasoning of co-design that occur between customers and smart UTCD and so provide the interaction patterns of smart UTCD for customization. I provide measures for firms, which permit them to select the adequate supports along with the smart UTCD for all kinds of customers, regardless of their innovative design skills, so that they can co-design their product according to their individual uses.

Literature Review

The Advent of Use Generative Goods

Smart products are defined as consumer products that integrate information and communication technology in a form of sensors, software, microchips and other types of components (Rijsdijk & Hultink, 2009). They are said to change drastically the applications of ordinary products by turning them into smarter, more adaptable, connectable versions (Rijsdijk, 2006; Rijsdijk & Hultink, 2009). Within these products, Brown (2013) recently observes the emergence of a new phenomenon that he calls “Use Generative Goods”. They are described in his seminal work as having specific product forms that, somehow, encourage users to generate uses to an increasing extent. Additionally, they, also, share the uniqueness to have undefined uses; the idea of producers being that customers should find them out on their own. Take the Raspberry Pie, for instance. It is a crude computer with an unusual form and no defined uses. Yet, users have generated a high number of uses. They find ways to utilize the Raspberry Pie for purposes as different as the spatial photography or computer programming learning (Brown, 2013).

Along with this phenomenon appears a new form of product - user interaction. It is based on the fact that all customers possess – to a more or less degree – innovative design skills. It becomes, for instance, evident with the iPad, where Apple’s objective was to develop a “generic” product with latent uses to empower customers to co-create solutions for their individual uses. So far, in the literature, Brown (2013) is the first one to bring this new notion of interaction “user – product” in the management literature, which adds to the two other types of interaction, that are, however, largely exploited in research. That is, the first form of interaction is from the Schumpeter’s theory, where users have no design skills (Schumpeter, 1934) and the second called the lead user theory, rather views, on the contrary, certain users as (lead) active designers (Franke, von Hippel & Schreier, 2006; von Hippel, 1986; von Hippel, 2005). Indeed, with the Schumpeter’s theory, customers are only passive recipients. In this framing, producers are the ones, who develop the entirety of products, while users interact with the finished product by means of the instruction manuals. In contrast, with the

lead user theory, von Hippel (1986) so as von Hippel (2005) shows that certain users are very skilled (lead) users, capable of developing products that suit the upcoming customer needs. Thereby, they should be the ones to focus on to develop new products, instead of producers. A renowned case is the skateboard. It is the result of a few “experts” users, who thought about disassembling a kind of roller skate so as hammered the wheels onto board (von Hippel, Ogawa & De Jong, 2011).

Further, it is interesting to see how customers attach a high value to these “use generative goods” (Brown, 2013). It is, also, reinforced by a great deal of evidence, which reveals, via the criterion of paying a premium, that products customized by customers are given more value than the standard versions (Franke & Piller, 2004; Franke & Schreier, 2010; Schreier, 2006). In the same line of research, Brander, Stich & Wender (2009) show further that, while customers are extremely irritated about the imperfections of ordinary products, they, in the other hand, give a high value to the ones they repurpose, even though with mistakes. Beyond it, these authors posit that it is the nature of each individual to repurpose their products i.e. the chair used as a bedside table or the lighter employed as a bottle opener. Yet, surprisingly, the success of the use generative goods remains scarce (Brown, 2013). That is, whereas a few like the iPad or Raspberry Pie succeeded, the majority of them failed in the market. Let’s take the case of the Nestlé Chocolate fondue, for instance, to better understand why it is so. It belongs to the phenomenon of use generative goods, even though not being smart. That is, Nestlé aimed with the Chocolate fondue at generating uses among their customers. For instance, the idea was to enable them to use it as a fondue with fruits on sticks, as a chocolate spread such as Nutella, or employ it in baking. Yet, the chocolate fondue was a flop; the reason provided by Gapihan & Le Mestre (2008) is that Nestlé misunderstood their customers.

Referring to von Hippel (1994; 1998), the issue is certainly due to the “sticky information”. The author defines it, as a user needs related information unit that is hard to transfer in a form usable from the customer’s recipient to the firm’s one. Resulting from it, the piece of information on the customer needs holds by firms is either wrong or incomplete, which results in the development of novel products i.e. the chocolate fondue that are unsuccessful in the market (Piller et al., 2010; Rosenberg, 1982). To overcome it, von Hippel (2001) so as von

Hippel & Katz (2002) propose to put into effect the notion of customer co-creation, which is a joint process where customers and firms are co-designers of those products fitting each of the individual needs. They do so by equipping customers with UTCD so that the “sticky” design task is entirely delegated to the customer domain in the product development. That is, in so doing, it enables customers to transform their latent needs into a concrete solution (Piller & Salvador, 2016). All of this is obviously based on the evidence that customers are capable of designing by themselves products (von Hippel, 1988).

Since the seminal work of von Hippel on the concept of UTCD, UTCD have been largely employed in the development of new products so that it suits exactly the customer needs i.e. Dell, Adidas, M&Ms, etc. Further, lately, UTCD have been transformed into smarter versions that possess better capability (Ernest-Jones, 2008). I call them “smart UTCD”. The particularity of these smart UTCD is that they can be directly integrated into purchased products, which permit customers to own products “with a built in flexibility”, which are a sort of subgroup of “use generative goods”. For instance, one of the existing application is with the Kinect. In the Kinect, Microsoft proposes an additional smart UTCD called SDK 2.0, which is concretely an app (Brown, 2013). With this added system, so as shown in Figure 3.1, it gives users the freedom to co-design unique solutions that respond to each of their individual uses. For instance, surgeons made use of SDK 2.0 to employ the Kinect in their practice or musicians to play virtually their instruments.



Figure 3.1. Some of the Unintended Uses Designed by Users with SDK 2.0 Shown at Bottom Right Corner
Source: Inspired by Brown (2013) & developer.microsoft.com

Smart User Toolkits for Co-design: A New Empowerment of Users to Co-design Uses

In the traditional literature, smart UTCD are conceptualized as some sets of complementary design tools that assist a layperson to co-design unfailingly the product they want with an iterative experimentation (von Hippel, 2001; von Hippel & Katz, 2002). Referring to von Hippel (2005), they all share the same characteristics, which are, first, to possess an user-friendly interface - either digital or physical - so that they are effortlessly operated, second, to provide a trial and error process in order to facilitate customer's efforts in his/her exploration of the ideal solution, third, to have the right solution space i.e. the basic rule is to encompass solutions sought by customers, fourth, to have a library of modules and functionalities so that customers are left with the task to find the ultimate solution.

Moreover, variants of smart UTCD exist in the market place. According to Thomke & von Hippel (2002), their scope, that is the design possibilities offered, is one component that differentiates them. Based on this criterion, Frank & Schreier (2002) define two types of smart UTCD i.e. low-end and high-end ones. In detail, a high-end one has a wider scope which permits to combine relatively basic and general-purpose building blocks and operations i.e. LEGO Mindstorms. By means of this set of design tools, customers are given the

possibility to “co-construct” (Prügl & Schreier, 2006). In contrast, with the low-end one, it uniquely offers a small solution space, which enables customers to select passively a few pre-defined options from lists. The advantage, obviously, is that all users regardless of their design skills are able to use them. Yet, the latter’s main purpose is rather to personalize a product i.e. configurator-like (Franke & Piller, 2004). A good illustration of a low-end toolkit is the ADIDAS one running shoes. With these sneakers, it enables customers to adjust automatically, via the integration of a low end smart UTCD into the cushioning part of the shoes, the compression characteristics of the midsoles whether they prefer a soft or firm ride. With such smart systems composed of a small plus and minus console with five gradient factory settings, customers are exclusively restricted to personalize the hardness degree of the heel pads according to their uses i.e. the terrain, the morphology, the running style, etc.

Since the pivotal idea of von Hippel (2001), von Hippel & Katz (2002) with UTCD, such research has been oriented towards the technical aspects of UTCD and the production environment associated (Franke & Piller, 2004). Nonetheless, for certain researchers, it is not sufficient (Franke & Piller, 2003; Piller & Salvador, 2016; Thomke, 2016). In particular, for Franke & Piller (2003) research has to tackle the challenging task of understanding in details the customer’s interaction with UTCD in the co-design activities. A reason relate to the literature on co-creation (see, e.g., Udwardia & Kumar, 1991), which shows that the realization of a co-construction – or co-design – can only happen if, from the customer’s side, his/her involvement is total in the co-design activities, starting from having a blurred idea of what they want. So far, reflecting the reality, certain smart UTCD lack to engage customers in the co-design of their ideal solutions (Prügl & Schreier, 2006). Although it is less of an issue with the low-end ones, which act like configurators, it is particularly true for high-end smart UTCD (Jeppesen, 2005). Franke & von Hippel (2003), for instance, demonstrated it with the Apache Software tool, which is a high-end smart toolkit. They reveal that only 37% of the Apache’s users felt to be able to create new solutions whereas the rest that represents 64% of them only sensed to be capable of using the solutions created by the first-mentioned users. Based on Franke & Piller (2003), it is because the interaction patterns of UTCD are still blurred, even though they are known by all researchers to be fundamental.

Dominant Design Theories

The dominant belief in engineering design is that the use of a product is an uncertain variable that should be fully controlled by firms (Brown, 2013). For instance, with the theory of the systematic design (Pahl & Beitz, 1996), the prevalent one applied in today's industry, the design of a product consists of coupling specified functionalities with a set of design parameters. In this scheme, uses are expressed as a set of propositions in the requirement specifications, which is then integrated in the design of a product. Suh (1990) even goes a step further by developing the axiomatic design theory, where the fundamental rule based design is the development of a product with independent subsystems, in which each of these systems has a functionality that corresponds to a use. It is evident with the Swiss army knife. Each of the object's subsystems i.e. screwdriver, can-opener, bottle-opener, etc. is designed for a unique use. However, the problem with these prevalent theories is that products are often kept in pre-existing models i.e. same object form and identity, the shared idea being that users should not spend time in understanding how to use a product (see, e.g., Suh, 1990). Thus, these products are kind of "inert" objects where all design efforts are supported by producers (Krishnan & Ulrich, 2001).

Yet, lately, there is another stream of research i.e. the modern design theories, where the ground rule refers to a different reasoning of design (see, e.g., Hatchuel & Weil, 2003; 2009; Hatchuel, Reich, Le Masson, Weil & Kazakci, 2013). The underpinning idea, is, as expressed by Hatchuel et al. (2013, p.5) that "design aims at defining and realizing an object that does not already exist, or that could not be obtained by a deduction from existing objects and knowledge". For example, when using a canonical model explained in detail by Le Masson, Weil & Hatchuel (2017), the focus can be on the reasoning of design of an artefact, which can be expressed – unlike dominant design theories – in details and funneled meticulously independently from the initial object identity. To date, however, the canonical model is, as stated by Le Masson et al. (2017), a very general, not specific model, a kind of minimal framework. To have a complete representation of a specific design regime, the four dimensions should obviously be set up. Thereby, following the work of Brown (2013), I propose to exploit the theory on the canonical model and its language in order to describe the

Article III. Interaction Patterns of Smart User Toolkits

reasonings of co-design that are involved in the interaction between smart UTCD and customers. Obviously, the study has an exploratory nature, as it is the first time that design theories are used in the research on UTCD.

Theoretical Framework for Use Generation

First, it is necessary to clarify what is the “use of a product”. Referring to Brown (2013), it is defined as “the act of using something, of applying a process, a technique, of activating an object, a material according to their nature, their function in order to obtain the effect that satisfies a need”. In view of that, certain verbs can be put together such as “act of using”, “applying”, “activating” as they all refer to a user action on the product. Further, the definition also permits to identify that the source of the action expressed in a form of set of requirements characterizing the seeking effect is “to satisfy a need”. Additionally, literature reveals that customers constantly repurpose the intended uses of products (Brandes et al., 2009). Therefore, it seems rather coherent to represent a product, not as an inert object, but instead as having a design space that gives the possibilities to customers to generate uses (Brown, 2013). Consequently, I propose to model a smart UTCD as possessing a design space for use generation. Furthermore, following the above definition of use, I suggest that this design space consists of the support of the meetings of actions and values. Besides that, in this representation, I intentionally replace needs by values, as the notion of “value” fits better in the context of smart UTCD. According to Schreier (2006), Franke & Schreier (2010) and Franke & Piller (2004), “value” is well suited as it also includes the desire of a user to utilize smart UTCD for the own sake. In details, the use of smart UTCD is not only to fulfill a need (i.e. a need reflects a condition of dissatisfaction that pushes users to employ a product in order to fulfill it) but also to experience fun in the co-design process. Thereby, it finally means that the use of a smart UTCD consists of addressing a value through a given action.

To illustrate the above definition of use, let’s take the example utilized by Brown (2013) with the bike sharing system, that is, the Velib, even though not being a smart UTCD. Focusing on the bike’s seat, the system is composed of two degrees of freedom, that is, the rotation and translation. Thereby, it limits the possible actions on the seat, which is either to act on the height or on the orientation. About the values linked to such actions, a shared one is to adjust the seat to one’s morphology for a comfortable ride. Yet, user created in this design space i.e. the seat, an unintended use, where the value is to signal that the bike is defect to other users

and the associated action to rotate the seat to 180 degrees from its initial position. In Figure 3.2. is the illustration of the uses of the bike's seat.



Figure 3.2. Illustration of the Unintended Use with the Velib
Source: In a Power Point Presentation of Brown from 2013

Following the modelling of the product based on the definition of use, the next step is to describe the design of a use. To do so, Brown (2013) proposes that it should fundamentally be defined as the result of an interaction between a user with his/her knowledge on a product and the product itself (or an element / several elements within the product i.e. the seat with the Velib). Focusing on the knowledge on a product, it depends, first, obviously on what is provided by firms to users such as the instruction manuals, object identity, object form (see, e.g., Bloch, 1995; Veryzer, 1995). Sometimes, there is none, as shown earlier with the Raspberry Pie.

Further, based on the example of uses of the Velib, it is evident that the modelling of a smart UTCD' design space possesses the evident uses (i.e. the meetings of actions and values) within two larger spaces of actions and values. That is, these spaces include actions and values, where users are the ones who should create the meetings. Altogether, the framework developed by Brown (2013) for use generation becomes finally a structure that he calls "canonic model of product-use", composed of four dimensions, that are, the knowledge of a user, the product's design space that should be defined, and within this design space, the actions space and the values space. In so doing, the framework finally permits to expose the reasonings of the co-design of uses based on a modelling of a product that has a design space that has to be defined, which includes two spaces, one of actions and one of values. Yet, in the paper, the object of focus being the smart UTCD, I propose to simplify the framework by representing uniquely the smart UTCD' design space that creates the solution space, the two

other dimensions i.e. the knowledge of the user on the product and the definition of the product's design space being not represented. Altogether, the model of a smart UTCD' design space is finally shown as follow in Figure 3.3. There are the actions space represented by a circle and the values space represented by a second one. Further, there are the meetings of actions/values located within the interaction between the actions space and the values space that represents the evident uses.

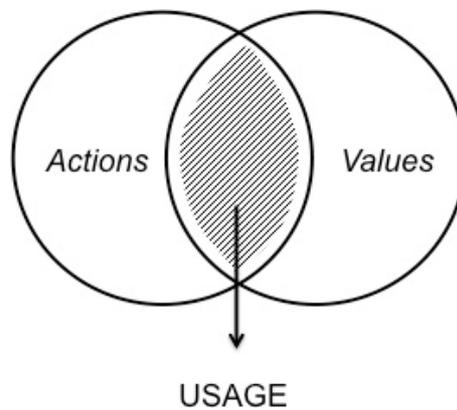


Figure 3.3. Basic Model Representation of a Product Carrying Design Space in Brown (2013)

Let's explain easily further the model by taking two non-smart UTCD products that are extremely different in terms of mechanisms of design of uses (see Figure 3.4). There are the Swiss army knife that has a set of uses previously defined by firms and the Missing Object of Konstantin Grcic, which has no previously defined uses (Brown, 2013). With the Swiss army knife, it already integrates a form of guidance i.e. a full set of actions with the associated values. That is, the travelling product is equipped for every eventuality of uses a user would encounter in outdoors activities i.e. using the knife to make a sandwich, utilizing the bottle opener to open a drink, etc. Therefore, the Swiss army knife is a good example of a product that has almost all the meetings between actions and values. However, not entirely, as users tend to repurpose the use of a product (Brandes et al., 2009). For instance, the knife is often used to open letters, which is clearly not an outdoor activity. In contrast, with the Missing Object designed by Konstantin Grcic, it is composed of a solid block of oak with two excavated handles where the designer does not provide uses. His aim was in fact to develop deliberately an artefact where the actions and the values are evident, due to the familiar and

meaningful form of the object, but the meetings between actions and values (i.e. evident uses) are not obvious. In Figure 3.4. is shown a modelling of both products in terms of reasonings of design of uses.

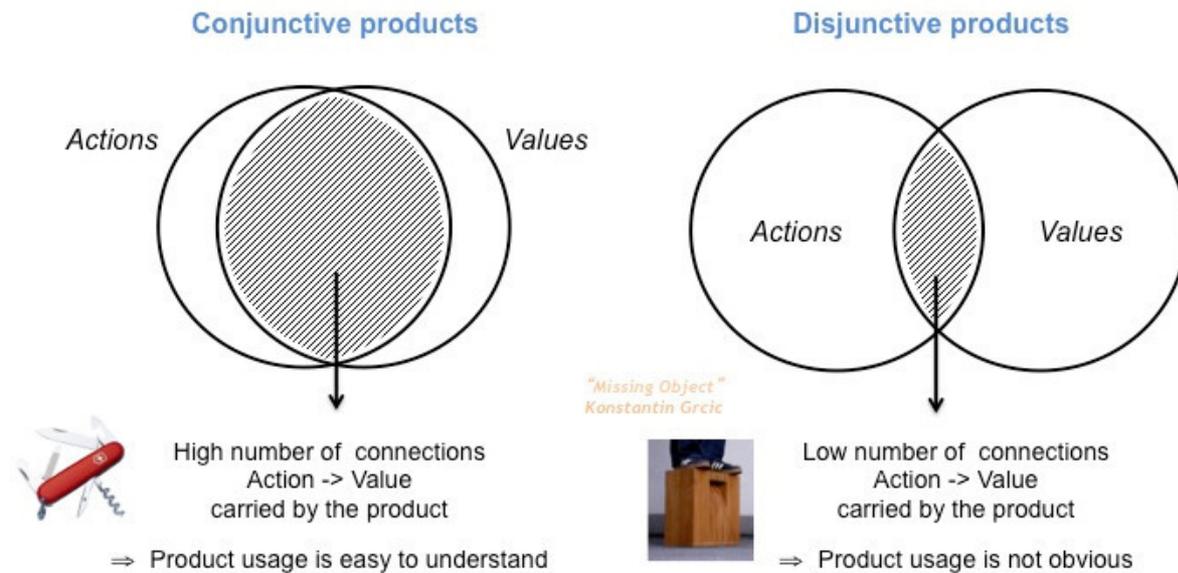


Figure 3.4. Modelling of the Swiss Army Knife and the Missing Object from Brown (2013)

Following this, it can be established, when the interactions are very large, the products like the Swiss army knife are represented. That is, most of the uses are evident to the users and the exploration of new uses, on the other hand, is hardly supported. In other words, it means that users know exactly on how to act on the product in order to obtain the associated value. In the C-K theory (Hatchuel & Weil, 2003; 2009) - which is a theory that distinguishes clearly between the spaces of concept (C) and spaces of knowledge (k) for a precondition of design - these **products are strongly conjunctives**. That is, they directly organize the link between a project of use a user expresses in the form of value proposal and a set of actions. Evidently, coming back to the framework of Brown (2013), the condition is that users must possess the piece of knowledge that supports their “conjunctive” design capacities of use i.e. to realize the uses defined by producers. In the case of the Swiss army knife, knowledge is for instance on how to use the can opener.

In contrast, when the interaction is thin, products like the Missing Object are represented. That is, they barely offer uses that are evident to users but propose a perfect setting for users to create new uses. That is, users can explore the actions space, the values space in order to create some meetings between both spaces. Based on the C-K theory (Hatchuel & Weil, 2003; 2009), these **products are strongly disjunctives**. That is, they propose users an actions space and values space, but never organize the meetings between both spaces. In other words, they propose no uses evident to users. Thus, it means when interacting with these products, following Brown (2013), users have then to appeal upon their “disjunctive” design capacities of use, which are to gather knowledge to formulate and apply projects of unknown uses. Obviously, it requires a greater design effort from users to realize these unknown uses.

Following this, the above modelling of the two products that are the Swiss army knife and the Missing Object will be used as basis in order to comprehend the reasonings (or mechanisms) of co-design between customers and smart UTCD.

Applying the Theoretical Framework for Use Generation on Smart UTCD

In this section, the modelling of the product's design space seen in the previous section is applied on the two existing types of smart UTCD (von Hippel & Katz, 2002). It enables to expose the reasonings (or mechanisms) of co-design with smart UTCD, identify the nature of this mechanisms carried out by smart UTCD and the associated difficulties that occur. In this regards, I selected as settings two smart UTCD in the product domains of toys and sport equipment i.e. the Adidas One running shoes and the Lego Mindstorms. The Adidas One is a low-end smart UTCD that consists of a sensor, microprocessor, user interface and a small console with a simple plus and minus button, which permits users to select up to five factory gradients settings of the compression characteristics of the heel pad. About the Lego Mindstorms, it is a high-end smart UTCD, composed of independent ICT components, which enables users to "co-construct" their toys from scratch.

The Adidas One Running Shoes – Low-End Smart UTCD to Optimize Uses

Overall, running shoes are modelled as conjunctive products. Whatever value proposal a user suggests; they offer spontaneously back an associated action. Furthermore, there are rare design possibilities left to create unintended uses. Concerning the Adidas One with the integration of a smart UTCD, it offers a new set of actions and values. That is, an obvious action is to press the button plus and minus of the small console and an associated value is to adjust the hardness degree of the heel pads according to the user's morphology. Therefore, both actions and values are clearly connected with each other.

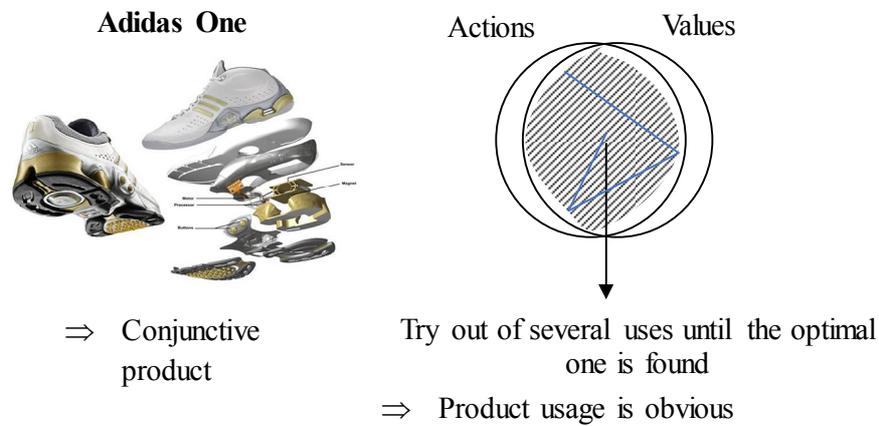


Figure 3.5. Modelling of the Low-End Smart Toolkit: Adidas One
Source: sneakersaddict.com

Thus, with this smart UTCD, the conjunctive aspect of the product is preserved as shown in Figure 3.5. That is, it offers new actions and new values that permit users to optimize the use of the products. With smart UTCD, users are now given the opportunity to optimize the compression characteristics of the heel pads according to their needs. For instance, let's imagine that a user selects one of the settings. After that, smart UTCD enables the user to try out this setting by adjusting automatically the cushioning part of the shoes. Then, when testing it in a real usage situation, user discovers that this gradient fits him/her. But, he/she can as well figure out that this setting misfits him/her as he/she feels discomfort while evaluating this option. Accordingly, he/she has the possibility to experience by himself/herself another setting and repeats the operations until he/she identifies the setting that suits him/her the best. Of course, in this frame, so as with the Swiss army knife in the previous section, prior basic knowledge on how to use the product is essential. Notably, it is said in the smart products' literature that it is especially uneasy for customers to understand how to operate them, which could be problematic for smart UTCD (Rijsdijk, 2006; Rijsdijk & Hultink, 2009).

The Lego Mindstorms – High-End Smart UTCD to Create Unknown Uses

Lego Mindstorms is classified as being a high end smart UTCD. By modeling it, it is clearly disjunctive in nature (see Figure 3.6.). With the system, users are not provided with evident

uses but instead are given the freedom to co-create unknown uses. That is, such smart UTCD offer users a set of possible actions so as of possible values but never provide the connections between the two spaces. Further, it is important to notify that the Lego Mindstorms - which is a good representation of high end smart UTCD present in the market - has the singularity not to provide evidently the set of actions and values to users. It is clearly a distinction in comparison with the Missing Object, where both sets were made obvious to the users through the form and identity of the product. Thus, for most customers – who are said to not have prior knowledge in most product domains (e.g., Bettman, Luce & Payne, 1998) - they have no idea on what to create with such high-end smart UTCD. Therefore, they have to make an insurmountable effort to design unknown uses. Explicitly, they should acquire knowledge on the products to get a blurred idea of what to co-design (i.e. develop a project of an unknown use) so as set up the connection between a set of actions and values.

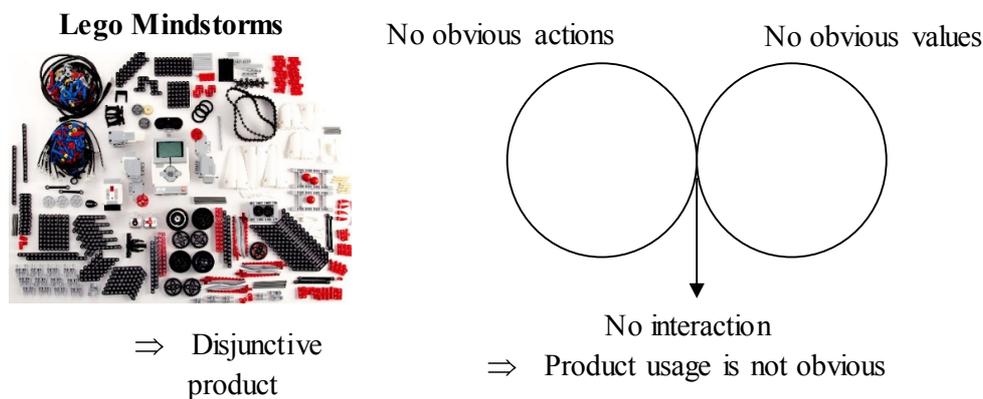


Figure 3.6. Modelling of the High-End Smart Toolkit: Lego Mindstorms
Source: Mindstorms Lego.com

To overcome this difficulty, based on the work of Agogu , Poirel, Pineau, Houd  & Cassotti (2014), the solution is to propose along with smart UTCD, an additional service in a form of tutorials of a few creations of disruptive uses. Let's illustrate it with the Lego Mindstorms. That is, Lego offers with the Mindstorms, unlike other smart UTCD of this kind, online tutorials of uses. In so doing, it permits to reproduce the proposed creations, acquire sufficient knowledge on the product, which empowers them to create their own i.e.

to develop some projects of unknown uses and make the necessary connection between the actions and values spaces. See in Figure 3.7.

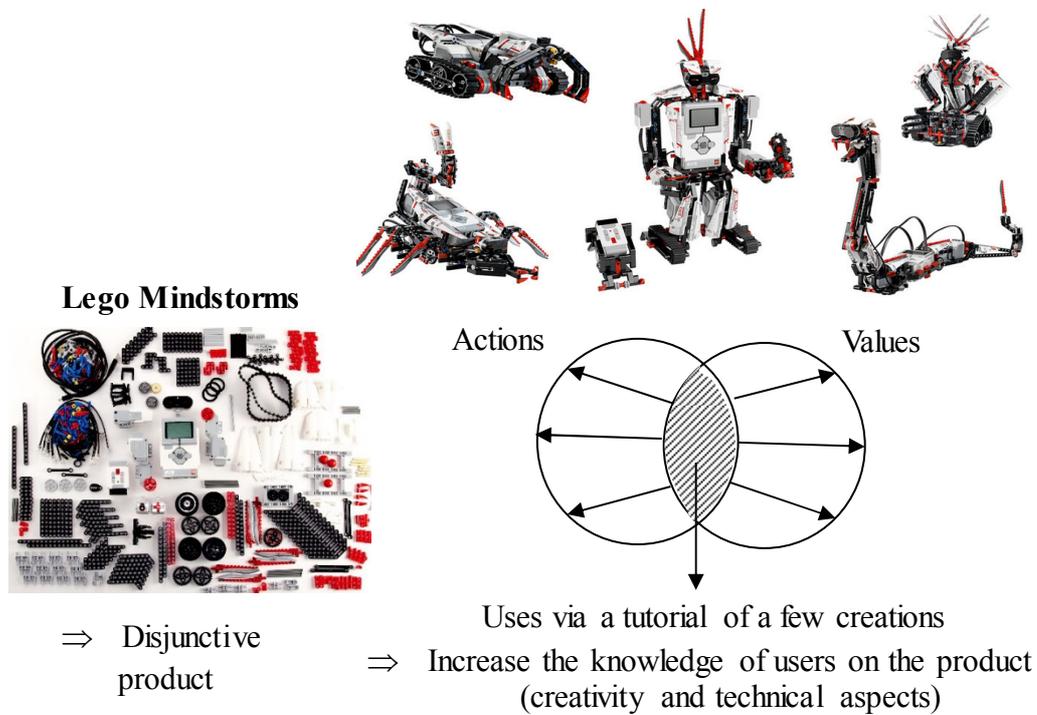


Figure 3.7. Modelling of the Smart High-End Toolkit: Lego Mindstorms with Tutorials of a Few Creations
Source: Mindstorms Lego.com

Findings

In this article, my aim was to define the interaction patterns of smart UTCD for co-design, the idea being that everyone should be able to co-design an ideal solution that responds to an individual use. By following this trajectory, I, first tried to understand the reasonings of co-design that occur between smart UTCD and customers. In what follows, I explain further my findings.

First, my findings suggest that the design of use is a fully-fledged design activity in the product development. In particular, my results show that it is of high importance for smart products integrating ICT. That is, these systems, more and more oriented towards connectivity, permit easily to create new functionalities to a greater degree (Bechtold et al., 2014). Thus, they possess better settings for use generation than non-ICT products, the iPad being a good archetype of it. Subsequently, as the phenomenon of smart products intensifies over the years, such results suggest that scholars who have been neglected for years this research aspect should catch up with it.

Second, following the work of Brown (2013) on use generative goods, I introduce in this article a new form of interaction of product-customer, which is based on the evidence that customers possess innovative design skills (see, e.g., Agogu e et al., 2014). I notably, refer to the conjunctive and disjunctive design capacities that each of the customers has to a greater or lesser degree (Hatchuel & Weil, 2003; 2009). Thereby, it is a different representation from the one of Schumpeter (1934), where users are considered as passive recipients with no design skills or from the one of von Hippel (1986), where only a few (lead) users are worth participating in the new product development. As a reminder, the conjunctive design capacities are described as the user's abilities to realize the projects of uses whereas the disjunctive design capacities refer to the ones that formulate projects of unknown uses. Both are fueled by knowledge (Jeppesen, 2005).

Then, after having made use of the theoretical framework for use generation (Brown, 2013), I expose the reasonings (or mechanisms) of co-design that occur between users and smart

UTCD. As a general finding, it is evident that the natures of the co-design activities related to two existing types of smart UTCD are different. In detail, my results describe the mechanism of co-design related to low-end smart UTCD as directly setting up the connection between a project of use a user expresses in a form of value proposal and a set of actions i.e. Adidas One. By making use of the language of the C-K theory (Hatchuel & Weil, 2003; 2009), these low-end toolkits are therefore considered by nature conjunctive. That is, while users are purposely limited to explore unknown uses, they are, on the other hand, closely guided to find an optimal solution within the various proposed combinations, the difficulty for customers could be not to have the minimal knowledge to operate the product. In contrast, my findings show that the reasoning of co-design with high-end smart UTCD is of another nature. My results reveal that users have to make an intensive effort with high-end smart UTCD to formulate projects of unknown uses and transform them into concrete solutions i.e. to define non-evident values and actions so as coupling a set of actions with values. Thereby, based on the papers of Hatchuel & Weil (2003; 2009) on the C-K theory, the high-end smart UTCD are disjunctive in nature. That is, users are given the possibilities to co-create unknown uses, but are not guided on how to do so. Notably, with high-end smart UTCD, the issue proper to the tools is that they do not give customers a sense of what to create.

Altogether, these findings are not only of general interest but also, beyond it, permit to provide theoretical and managerial implications on smart UTCD.

Discussion and Implications

First, by exposing the reasoning of co-design with smart UTCD, it contributes to the literature that focuses on the differentiation between low end and high toolkits. To date, research shows that the difference is rooted in the design and the size of the solution space i.e. built in block for high-end ones, configurator like for low-end toolkits (Franke & Schreier, 2002; Prügl & Schreier, 2006). In fact, literature that addresses it further identifies the size of the solution space as the main element that differentiates the toolkits (see, e.g., Abdelkafi, 2008; Hermans, 2012; von Hippel & Katz, 2002). For instance, von Hippel & Katz (2002) posit that, while low-end toolkits should have a rather small solution space as to not overstrain customers,

high-end ones should possess a large solution space so that solutions sought by customers are included. Yet, relying on my findings, I argue that the differences between (smart) UTCD are less about the size of the solution space, which is a rather debatable criterion, but rather related to the design. That is, my results uncover conditions under which the differentiation holds. While low-end toolkits should be conjunctive to assist users to optimize specific product's features, in contrast, high-end ones have to be disjunctive to permit customers to co-construct their solutions.

Second, by pinpointing the difficulties that occur in the co-design activities with smart UTCD from the customer's side, it enables me to identify measures in a form of complementary services under which these mechanisms of co-design are more effective for the mass. Notably, my findings suggest that, while it can be confirmed that a service such as providing instruction manuals is necessary to give the minimum of knowledge to customers to start to co-design with low-end toolkits, given the fact, they are conjunctive products, in contrast, regarding high-end toolkits, the results show that the current services are incomplete and fuzzy. In this matter, my findings adds to the current literature, where the shared notion is to provide uniquely with high-end toolkits, user communities (or user to user assistance) in order to assist technically less skilled users in their activities of co-design (Franke & Shah, 2003; Jeppesen, 2005; Lakhani & von Hippel, 2003). It does so by identifying that the issue of co-designing with high-end toolkits from the customer's side, is less about their lack of technical skills (i.e. coupling the set of actions with the ones of values) but, rather the fact that, they have no clues on what to create with high-end toolkits i.e. high end smart UTCD do not support them to find projects of unknown uses. Looking back at the Apache Software's case (Franke & von Hippel, 2003), it seems to reflect the reality on high-end smart UTCD. Thereby, in this regard, I suggest proposing a tutorial of a few creations as an additional service, which proved already its effectiveness by providing customers the right knowledge to co-construct their own solution with high-end UTCD. In the case of the Lego Mindstorms, Lego clearly succeeded to transform laypersons into "creator-designers" with their tutorials. Besides that, it is also fueled by the recent findings of Agogué et al. (2014) that show that the solution related to the issue of the fixation effect is to provide disruptive examples of uses.

Yet, there is a limitation to this study that must be notified to the readers, that is, it remains a theory. Therefore, it would be noteworthy for further research to confirm these findings by reproducing the field experiment of Agogu  et al. (2014).

Additionally, related to the previous point, the findings permit eventually to provide producers with the interaction patterns of smart UTCD essential to all customers. That is, with high-end UTCD, tutorials of a few creations are crucial, next to the user community or user-to-user assistance and with low end UTCD, instructions manuals are the solution. Besides that, such services permit also firms to encourage further users to exploit more of the possibilities of uses available with UTCD, to take care of the customers who do not understand the limit of their own design capacities, but also the ones with no design skills. Without additional services, these customers would indeed be left with artefacts they are unable to use. Furthermore, by providing tutorials of a few creations with high-end toolkits, customers, as stated by Jeppesen (2005), are likely to generate more and more unknown uses, which can be of interest for firms. That is, with the retrieve of user data by means of smart UTCD, firms can benefit from it by collecting data related to the upcoming market trends or on how to improve their products (Marketing Science Institute, 2016).

Moreover, what has not been considered in the paper is the size of the solution space, which could be addressed further in research. That is, the modelling of the smart UTCD' design space (i.e. the space of values and the space of actions) did not include the size of the solution space. It means that it has not been taken care of in this paper, even though there is hardly research on it (Piller, 2005; Piller et al., 2010). For instance, I suggest for future research, inspired by the literature on the customer choices of Miller (1956), Botti & Iyengar (2006) so as Schwartz (2004), to determine the magical number of the maximal solutions within low-end UTCD. From the above research, it seems to be that there is a number, where customers are overwhelmed by the high possibilities of combinations at their disposal and so no longer able to decide for one of the solutions. As stated by Miller (1956), there is something related to the customers' limited capacities to process information.

Conclusion

Altogether, this dissertation aimed at fulfilling the research gap revealed by Franke & Piller (2003) on the interaction patterns of smart UTCD that were said to be fuzzy. In so doing, the article, first, permitted to open the black box on the reasonings of co-design that occurs between customers and smart UTCD, identify the natures of the mechanisms of co-design related to smart UTCD' type, so as the difficulties that occur in the co-design activities from the customer's side. Second, it enabled finally to propose additional services that enhance the co-design activities of all customers with smart UTCD so that they can obtain their ideal solution for a specific use. Besides that, it additionally contributes to a broader literature on co-creation with a layperson by showing how the use of design theories helps to expose the reasonings of co-design. In this way, my article is a first step towards a more holistic view on customer co-creation with smart UTCD. Beyond the theoretical implications, the paper offers managerial implications. It proposes, notably measures in a form of additional services to encourage producers to tap the opportunity of smart UTCD by enabling them to increase their chance of success with these products. That is, it gives firms interaction patterns of smart UTCD so that all customers can co-design what they want for each of their individual uses. That is, it proposes firms to include, along with high-end smart UTCD, some tutorials of a few creations like how Lego Mindstorms realised it, while with low-end smart UTCD, it supports the notion that instruction manuals are needed, so as for every conjunctive product.

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Appendix 1. Scenarios Extracted from the Doodle Video on the Tasker

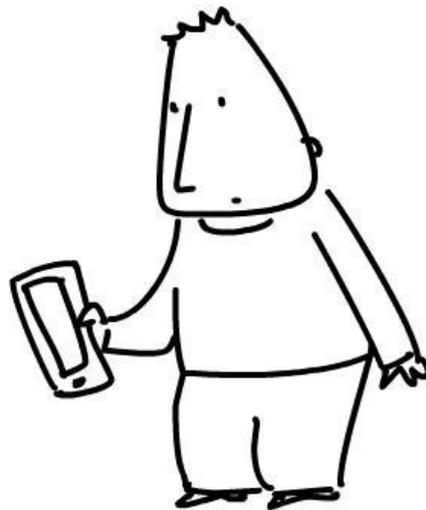
INTEGRATED CONFIGURATOR

for your mobile phone

The INTEGRATED CONFIGURATOR for your mobile phone is a very clever tool to enhance your mobile phone features according to your needs and make your phone truly deserve the name "smart phone".



It is really easy and intuitive to use. So don't worry - it is not necessary for you to have expert knowledge in order to make these changes.





Now let's see for some examples how you can improve your mobile phone with the **INTEGRATED CONFIGURATOR**

INTEGRATED CONFIGURATOR will tune the **MP3 player** of your phone so it will be more intelligent.



For example you can automatically launch your favorite songs on your MP3 player whenever the headphone is plugged in ...



... or adjust the playback volume automatically depending upon ambient noise level ...

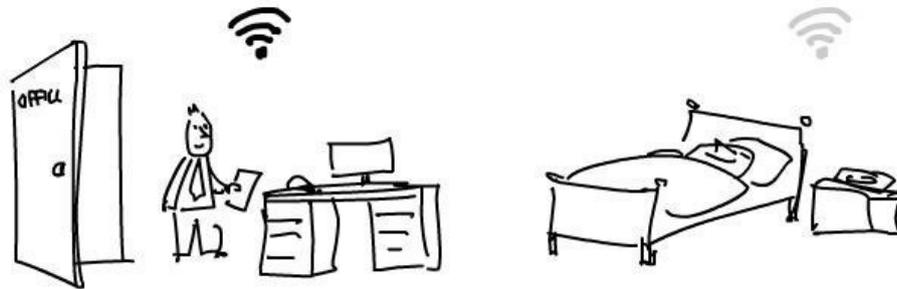


... or choose a song with relates perfectly with the movement speed of your body !

Modern mobile phones contain many useful features such as GPS, WLAN, 3G-Internet and large screens.

Unfortunately they consume a considerable amount of energy and thus rapidly drain your phone's battery.

An **INTEGRATED CONFIGURATOR** will enable you to automatically turn on/off energy-intensive features according to your preferences.



You can easily configure your phone to automatically activate the WLAN, whenever you are at home or at your office and/or deactivate the connections while you sleep at night.

An **INTEGRATED CONFIGURATOR** will make your mobile phone's **camera** just a little brighter.

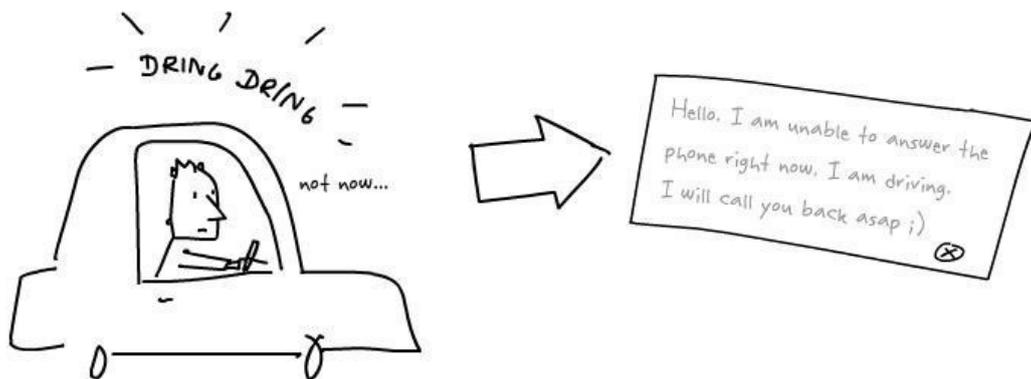


Imagine your phone would instantly find background information on objects you take a picture of using an appropriate web service (e.g. Google) and display this information as a popup notification.

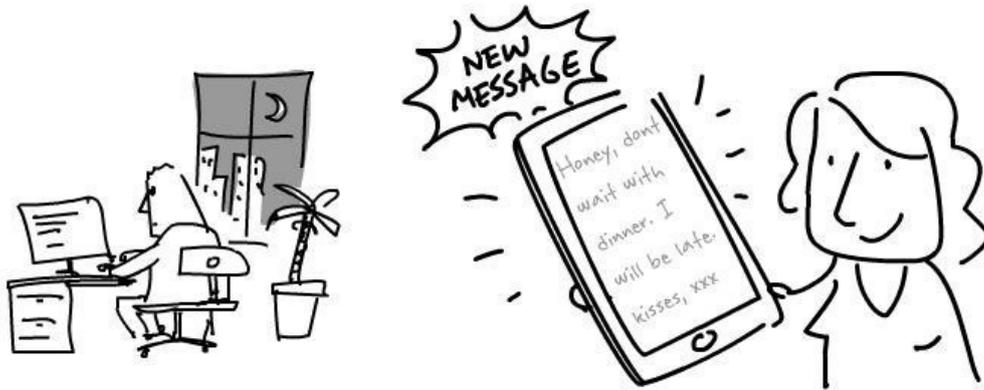


Or you can set up your phone to automatically send a photo to your friends, whenever it is taken.

An **INTEGRATED CONFIGURATOR** will offer you increased flexibility and control when using the **messaging** features.

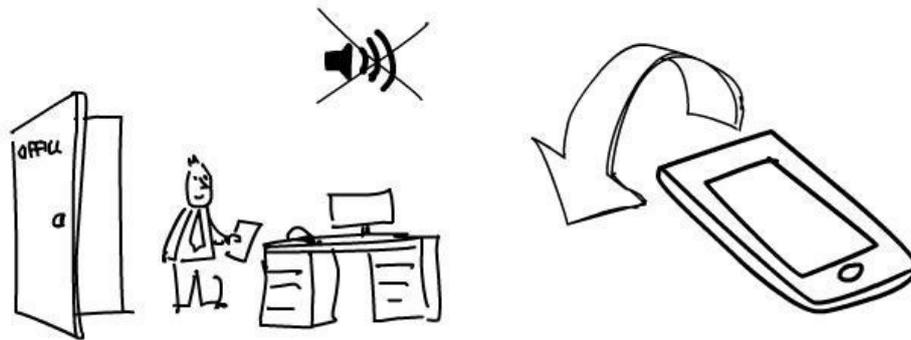


Your phone could automatically send a text message or E-Mail to callers attempting to reach you while you are busy (e.g. driving, in a meeting, sleeping, etc.).



Alternatively, you can configure your phone to automatically inform family members via sms, if your day at the office turns out to be longer than you originally planned.

An **INTEGRATED CONFIGURATOR** can smart up your phone when making/receiving calls.

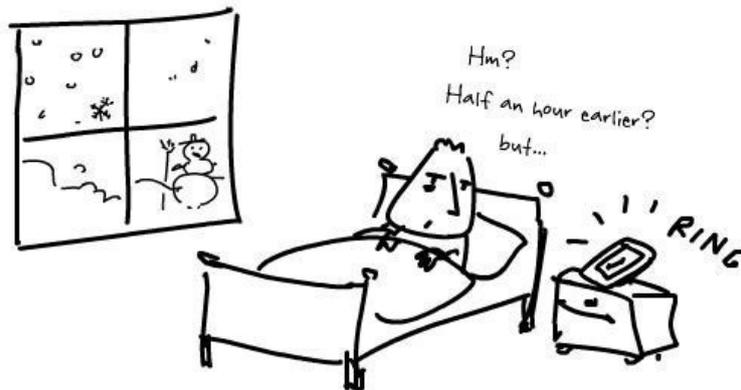


You can configure your phone to automatically switch to "silent-mode" whenever you arrive at the office and/or a meeting begins. Furthermore, you could easily program a "silent mode", whenever the phone is placed face down on a table.



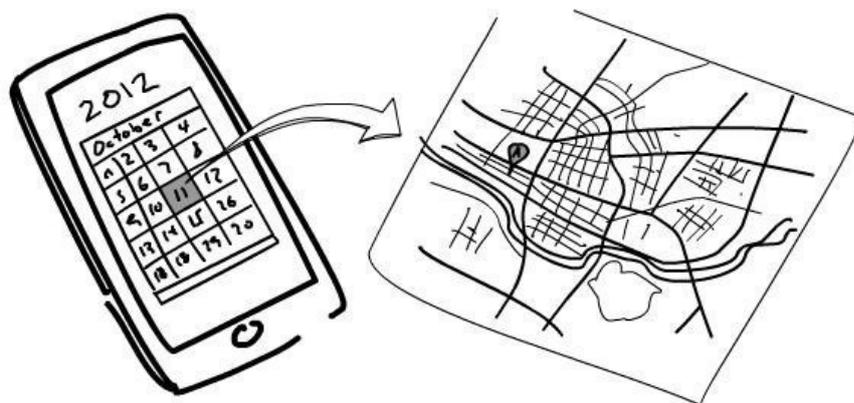
You can also define a number of people, who would still be able to reach you even though your phone is in "silent-mode".

An **INTEGRATED CONFIGURATOR** can also be used to enhance your phone's **alarm clock**.



The wake up time can be automatically adjusted according to the weather forecast, current road conditions, traffic density and/or the location of the first appointment recorded in your calendar.

An **INTEGRATED CONFIGURATOR** can combine the knowledge of the phone's navigation system with the punctuality of your calendar.



For example, you can customize your phone to automatically retrieve the location of your next appointment from your calendar and calculate the required transit-time based on information from the navigation system ...



... and then remind you via pop up notification or alarm clock when it is time to leave and automatically launch the navigation system with the appropriate destination.

INTEGRATED CONFIGURATOR

turns your mobile really into a smart phone !

Appendix 2. Exemplary Scenario Presented to Respondents and The Online Survey

In order to understand your preferences for "user toolkits", you are kindly asked in the following part of the survey to make a hypothetical choice between alternative versions of a "user toolkit" for mobile phones. The versions differ in their range of adaptable features (e.g. battery, MP3 player, navigation system, alarm clock, messages, calendar, calling etc.), in their degree of user friendliness and user support as well as in their terms and conditions.

Below is shown an exemplary of choice situation:

	Version A	Version B
Range of adaptable features & functions	20 adaptable features and functions	15 adaptable features and functions
User interface hardware	via mobile & computer	via mobile only
User interface software	graphical interface with drag and drop	Some command programming required
Instant test simulations	yes, test simulations possible	no, needs to be tested in action
User support by provider	online tutorials & direct user help desk	none
User support by online community	no online community	yes, online community available
Advertisements during usage	no advertising	with advertising
Data privacy	no, some personal data sold	yes, privacy ensured
Price	0.00 US\$	0.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A Version B None

Appendix 3. Exploratory Factors Analysis

Construct: Perceived usefulness; Cronbach α = .94; explained variance = 90,1%	
Item: statement*	Item-to-total
Compared to standard mobile phones, using a mobile phone with an embedded toolkit would.....	
pu1: ... better satisfy my requirements.	.900
pu2: ... better meet my personal preferences.	.923
pu3: ... more likely fit my image of a perfect mobile phone.	.831
Construct: Perceived enjoyment; Cronbach α = .95; explained variance = 87.6%	
Using an "embedded toolkit" in order to adapt certain features or characteristics of my mobile phone according to my preferences...	
pe1: ... would be exciting.	.878
pe2: ... would be fun for its own sake.	.906
pe3: ... would be enjoyable.	.937
pe4: ... would be interesting.	.819
Construct: Perceived complexity of use; Cronbach α = .96; explained variance = 88.9%	
Using an "embedded toolkit" in order to adapt certain features or characteristics of my mobile phone according to my preferences...	
peu1: ... would be too complicated.	.886
peu2: ... would take too much time.	.902
peu3: ... would be too confusing for me.	.885
peu4: ... would take too much effort to become skillful at it.	.917
Construct: Behavioral intention to use; Cronbach α = .94; explained variance = 85.1%	
bi1: Assuming that I have accessed to an "embedded toolkit" for mobile phones, I would intend to use it.	.897
bi2: Given that I have access to an "embedded toolkit" for mobile phones, I would predict that I would use it.	.892

bi3: I would certainly look for more information on "embedded toolkits" for mobile phones.	.820
bi4: I would probably recommend that my friends use an "embedded toolkit" for mobile phones.	.828

* All items were rated on 7 point Likert scales with anchors "strongly disagree - strongly agree".

Construct: Perceive product customization; Cronbach $\alpha = .88$; explained variance = 80,2%

Item: statement*	Item-to-total
dc1: For my mobile phone, I chose an individual combination of features.	.718
dc2: when buying my mobile phone, I paid special attention to certain features that meet my preferences.	.753
dc3: I try to customize my current mobile phone, so that it would exactly fulfill my individual needs.	.819
^a dc4: My current mobile phone is almost identical and unaltered compared to the standard or base model.	--

Construct: Feature fatigue; Cronbach $\alpha = .84$; explained variance = 75,5%

^a u1: It is easy to get my mobile phone and all its features to do what I want them to do.	--
u2: My mobile phone contains too many irrelevant features that are not of interest to me.	.688
u3: Many features of my mobile phone are basically useless to me.	.754
u4: Using certain features of my mobile phone is often difficult and exhausting.	.660

Construct: Preference variability; Cronbach $\alpha = .86$; explained variance = 87,5%

hp1: My preferences concerning mobile phone features and characteristics constantly change.	.750
hp2: I often have changing or even new requirements for my mobile phone.	.750

Construct: Preference insight; Cronbach $\alpha = .90$; explained variance = 83,0%

pi1: Regarding mobile phones, I know exactly what I want.	.801
pi2: When I purchase a mobile phone, I usually know quite soon what I prefer.	.845
pi3: When I purchase a mobile phone, I find it easy to choose among different alternatives.	.748

* All items were rated on 7 point Likert scales with anchors "strongly disagree - strongly agree".

^a Item was deleted in further analysis.

Appendix 4. Experimental Design

Version 1	Visualization		Help Functions		Number of Adaptable Features		Price		Intrusion		Scenario
	Profile A	Profile B	Profile A	Profile B	Profile A	Profile B	Profile A	Profile B	Profile A	Profile B	
1	mobile, comand, no test simulation	mobile & computer, drag & drop, with test	none	with tutorials, user community	5	10	0\$	0.99\$	no advertising, personal data sold	no advertising, privacy ensured	1
2	mobile & computer, comand, with test simulation	mobile, comand, with test simulation	with help desk	with user community	15	10	4.99\$	0.99\$	with advertising, privacy ensured	with advertising, privacy ensured	2
3	mobile, comand, no test simulation	mobile, drag & drop, with test simulation	with tutorials, help desk, user community	with tutorials	20	5	4.99\$	2.99\$	no advertising, personal data sold	with advertising, privacy ensured	3
4	mobile, drag & drop, with test simulation	mobile & computer, drag & drop, no test simulation	none	with tutorials, help desk	20	10	0.99\$	2.99\$	with advertising, privacy ensured	no advertising, privacy ensured	4
5	mobile, drag & drop, with test simulation	mobile, comand, no test simulation	with tutorials, user community	with tutorials, help desk, user community	10	15	2.99\$	0.99\$	no advertising, privacy ensured	with advertising, privacy ensured	5
6	mobile & computer, drag & drop, with test simulation	mobile & computer, drag & drop, with test simulation	with tutorials, help desk	with help desk	15	15	0\$	0\$	no advertising, privacy ensured	With advertising, personal data sold	6
7	mobile, comand, no test simulation	mobile & computer, comand, with test simulation	with tutorials, user community	with help desk, user community	5	20	4.99\$	2.99\$	with advertising, privacy ensured	no advertising, personal data sold	7

Version 2	Visualization		Help Functions		Number of Adaptable		Price		Intrusion		Scenario
	Profile A	Profile B	Profile A	Profile B	Profile A	Profile B	Profile A	Profile B	Profile A	Profile B	
1	mobile & computer, drag & drop, with test simulation	mobile & computer, drag & drop, no test simulation	with tutorials, user community	none	5	10	4.99\$	4.99\$	no advertising, personal data sold	With advertising, personal data sold	8
2	mobile & computer, drag & drop, no test simulation	mobile, comand, no test simulation	with tutorials, user community	with user community	20	20	0\$	2.99\$	With advertising, personal data sold	with advertising, privacy ensured	9
3	mobile, drag & drop, no test simulation	mobile, drag & drop, with test simulation	with help desk, user community	with tutorials, user community	15	20	0\$	4.99\$	no advertising, privacy ensured	no advertising, personal data sold	10
4	mobile, comand, with test simulation	mobile & computer, drag & drop, with test simulation	none	with tutorials, user community	10	15	0.99\$	0.99\$	With advertising, personal data sold	With advertising, personal data sold	11
5	mobile & computer, comand, no test simulation	mobile & computer, comand, no test simulation	with tutorials, help desk, user community	with tutorials, help desk	15	15	0.99\$	0.99\$	With advertising, personal data sold	with advertising, privacy ensured	12
6	mobile & computer, comand, no test simulation	mobile & computer, drag & drop, no test simulation	with help desk, user community	with help desk, user community	10	5	2.99\$	4.99\$	no advertising, privacy ensured	no advertising, privacy ensured	13
7	mobile & computer, drag & drop, with test simulation	mobile, comand, with test simulation	with help desk, user community	with tutorials, help desk	10	10	2.99\$	0\$	With advertising, personal data sold	no advertising, personal data sold	14

Version 3	Visualization		Help Functions		Number of Adaptable		Price		Intrusion		Scenario
	Profile A	Profile B	Profile A	Profile B	Profile A	Profile B	Profile A	Profile B	Profile A	Profile B	
	mobile & computer, comand, no test simulation	mobile & computer, drag & drop, no test simulation	with tutorials, help desk, user community	with tutorials, user community	10	10	0\$	0\$	with advertising, privacy ensured	With advertising, personal data sold	
1	mobile & computer, comand, no test simulation	mobile & computer, drag & drop, no test simulation	with tutorials, help desk, user community	with tutorials, user community	10	10	0\$	0\$	with advertising, privacy ensured	With advertising, personal data sold	15
2	mobile & computer, drag & drop, no test simulation	mobile, drag & drop, no test simulation	with user community	none	20	15	4.99\$	0.99\$	with advertising, privacy ensured	no advertising, personal data sold	16
3	mobile, drag & drop, with test simulation	mobile & computer, comand, no test simulation	with tutorials, help desk	with tutorials, user community	15	5	2.99\$	4.99\$	With advertising, personal data sold	no advertising, personal data sold	17
4	mobile & computer, drag & drop, with test simulation	mobile & computer, comand, with test simulation	with help desk, user community	with user community	10	15	0.99\$	2.99\$	no advertising, personal data sold	no advertising, privacy ensured	18
5	mobile, comand, with test simulation	mobile, drag & drop, no test simulation	with help desk, user community	with help desk	5	20	0\$	4.99\$	With advertising, personal data sold	with advertising, privacy ensured	19
6	mobile & computer, comand, no test simulation	mobile & computer, comand, with test simulation	none	with tutorials, help desk	20	20	2.99\$	4.99\$	no advertising, personal data sold	With advertising, personal data sold	20
7	mobile & computer, drag & drop, no test simulation	mobile, drag & drop, with test simulation	with tutorials	with tutorials, help desk, user community	5	10	0.99\$	0.99\$	no advertising, personal data sold	no advertising, privacy ensured	21

Version 4	Visualization		Help Functions		Number of Adaptable		Price		Intrusion		Scenario
	Profile A	Profile B	Profile A	Profile B	Profile A	Profile B	Profile A	Profile B	Profile A	Profile B	
1	mobile, drag & drop, no test simulation	mobile & computer, comand, no test simulation	with help desk	with tutorials	5	20	4.99\$	0\$	no advertising, privacy ensured	with advertising, privacy ensured	22
2	mobile & computer, comand, with test simulation	mobile, drag & drop, with test simulation	with tutorials	with tutorials	5	15	2.99\$	2.99\$	with advertising, privacy ensured	no advertising, privacy ensured	23
3	mobile, comand, with test simulation	mobile & computer, comand, with test simulation	with tutorials, user community	none	20	10	0\$	0.99\$	no advertising, privacy ensured	no advertising, privacy ensured	24
4	mobile, comand, with test simulation	mobile, drag & drop, no test simulation	with tutorials, help desk	with help desk, user community	20	20	4.99\$	0\$	no advertising, personal data sold	no advertising, personal data sold	25
5	mobile & computer, comand, with test simulation	mobile, comand, no test simulation	with user community	with tutorials, help desk, user community	15	5	0.99\$	2.99\$	with advertising, privacy ensured	With advertising, personal data sold	26
6	mobile, drag & drop, no test simulation	mobile, comand, with test simulation	with tutorials, help desk	with help desk	10	5	0.99\$	4.99\$	no advertising, personal data sold	With advertising, personal data sold	27
7	mobile, drag & drop, no test simulation	mobile & computer, drag & drop, with test simulation	with user community	with help desk, user community	15	5	2.99\$	0\$	With advertising, personal data sold	with advertising, privacy ensured	28

Anzeigeoptionen

Info: Hier können Sie optional die Anzeigeoptionen verändern. Wenn Sie eine Sprache auswählen, die keine eigenen Textelemente hat, werden die Textelemente der Standardsprache angezeigt.

Anzeigeoptionen einstellen:

- Filter anzeigen
- Pretest-Kommentare anzeigen
- Todos anzeigen
- Trigger anzeigen
- Plausichecks anzeigen
- Randomisierung abschalten
- Interne Verlinkungen ausblenden
- Nur den Fragebogen ausdrucken

Sprache

Deutsch
Englisch

Einstellungen speichern

Informationen zur Umfrage Embedded_Toolkit_Mobile

Umfrage-Nr.	435697
Autor	Morgane Benade
Mitarbeiter	
Start	2012-07-01 00:00:00
Ende	2012-11-30 00:00:00

Fragebogen

1 [Seiten-ID: 2706063] [L]

Welcome participants

Welcome to you!

Your opinion about **Integrated Configurators** for mobile phones is important to us, the **Technology and Innovation Management Group at RWTH Aachen University in Germany**.

Please take part in our short online survey which should take only 10 minutes of your time.

Be assured that all data handling and analysis will be **anonymous** and **strictly confidential**.

Thank you very much for your participation!

Best regards,

The Technology and Innovation Management team at RWTH Aachen University

*If you have **any questions** or if you **need help feel free to contact** Mrs. Morgane Benade at any time:*

benade@tim.rwth-aachen.de



2 [Seiten-ID: 2749282] [L]

Start of the survey

"Integrated configurator" for mobile phones

"Integrated configurator" for mobile phones are based on the idea of giving mobile phone users more options to make adaptations to their mobile phone features according to their preferences or needs after the purchase and during the use of their mobile phones. Besides, the user interface is designed in such an intuitive manner that it is unnecessary for users to have expert knowledge in order to make changes to their mobile phones.

Below are shown seven popular features of a mobile phone. In the following, you are asked to choose three of them. In the next page, It will be presented to you the three chosen features with some exemplary adaptability options, which can be provided by an "integrated configurator".

Please choose below three mobile phone features.

- MP3 Player
- Energy Saver
- Camera
- Messages
- Calls
- Alarm Clock
- Calendar / Navigation System

3 [Seiten-ID: 2717121] [L]

Explanations

Exemplary scenarios for the adaptability of mobile phone features

MP3 Player

An "integrated configurator" will enable you to configure the MP3 player of your phone according to your preferences. For example you can either automatically launch your favorite songs on your MP3 player whenever the headphone is plugged in and/or adjust the MP3-playback volume automatically depending upon ambient noise level and the movement speed of your body.

Energy Saver

While current mobile phones contain many useful features such as GPS, WLAN, 3G-Internet and large screens, which often consume a considerable amount of energy and thus rapidly drain a phone's battery, an "integrated configurator" will enable you to automatically turn on/off energy-intensive features according to your preferences. Furthermore, you can also easily configure your phone to automatically activate the WLAN, whenever you are at home or at your office and/or deactivate the connections while you sleep at night. Another illustration can be to set up your phone to turn off GPS, WLAN and 3G-Internet and/or dim the brightness of your screen whenever the battery level falls below a certain threshold.

Camera

An "integrated configurator" will offer you improved functionality of your mobile phone's camera. For example, you can configure your mobile phone to automatically attempt to find information on photographed items using an appropriate web service (e.g. Google) and display the retrieved information as a popup notification. Furthermore, you can set up your phone to automatically send a photo to your friends, whenever it is taken.

Messages

An "integrated configurator" will offer you increased flexibility and control when using messaging features. You can set up your phone to automatically send a text message or E-Mail to callers attempting to reach you while you are busy (e.g. driving, in a meeting, sleeping, etc.). Alternatively, you can configure your phone to automatically inform family members via messaging functionality, whenever your day at the office turns out to be longer than you originally planned.

Calls

An "integrated configurator" will offer you increased flexibility and control when making/receiving calls. You can configure your phone to automatically switch to "silent-mode" whenever you arrive at the office

and/or a meeting begins. You can also define a number of people, who would be able to reach you even though your phone is in "silent-mode". Furthermore, you can configure as well a "silent mode", whenever you are in an appointment and the phone is placed face down on a table.

Alarm clock

An "integrated configurator" can also be used to enhance your phone's alarm clock functionality. You can for instance customize the alarm clock and use a combination of different ring tones with increasing volume. Furthermore, the wake up time can be automatically adjusted according to the weather forecast, current road conditions, traffic density and/or the location of the first appointment recorded in your calendar.

Calendar/Navigation systems

An "integrated configurator" can be used to improve the integration of your navigation system with the phone's calendar. For example, you can configure your phone to automatically retrieve the location of your next appointment and preferred mode of transportation from your calendar and calculate the required transit-time based on information from the navigation system. In addition, your phone can remind you via pop up notification and/or alarm clock to leave with sufficient lead time and automatically launch the navigation system with the appropriate destination.

4 [Seiten-ID: 2706075] [L]

Perceived usefulness source "F. Steiner"

Your opinion about "integrated configurators"

In this part of the survey, please imagine that your mobile phone has an "integrated configurator" and provide your overall evaluation about "integrated configurators" by commenting on the following statements.

With the help of an "integrated configurator" I could adapt my mobile phone much more closely to my needs than it would be possible without such a system.

strongly disagree strongly agree

By using an "integrated configurator", I could much better customize my mobile phone according to my preferences than a manufacturer could do before purchase.

strongly disagree strongly agree

An "integrated configurator" would allow me to meet much better those needs that I only discover after the purchase while using my mobile phone.

strongly disagree strongly agree

By the means of an "integrated configurator" I could utilize the existing features of my mobile phone much more effectively.

strongly disagree strongly agree

5 [Seiten-ID: 2706076] [L]

Perceived Enjoyment "Davis et al., 1992; Childers et al.2001"

Your opinion about "integrated configurators"

Using an "integrated configurator" in order to adapt certain features or characteristics of my mobile phone according to my preferences...

... would be exciting.

strongly disagree strongly agree

...would be fun for its own sake.

strongly disagree strongly agree

...would be enjoyable.

strongly disagree strongly agree

...would be interesting.

strongly disagree strongly agree

6 [Seiten-ID: 2729979] [L]

Perceived Ease of Use "Venkatesh et al, 2003"

Your opinion about "integrated configurators"

Using an "integrated configurator" in order to adapt certain features or characteristics of my mobile phone according to my preferences...

... would be too complicated.

strongly disagree strongly agree

... would take too much time.

strongly disagree strongly agree

... would be too confusing for me.

strongly disagree strongly agree

... would take too much effort to become skillful at it.

strongly disagree strongly agree

7 [Seiten-ID: 2706077] [L]

Behavior intention to use it "Venkatesh and Davis, 1996"

Your opinion about "integrated configurators"

Please provide now your overall evaluation about "integrated configurators" by commenting on the following statements.

Assuming that I have accessed to an "integrated configurator" for mobile phones, I would intend to use it.

strongly disagree strongly agree

Given that I have access to an "integrated configurator" for mobile phones, I would predict that I would use it.

strongly disagree strongly agree

I would certainly look for more information on "integrated configurators" for mobile phones.

strongly disagree strongly agree

I would probably recommend that my friends use an "integrated configurator" for mobile phones.

strongly disagree strongly agree

8 [Seiten-ID: 2733379] [L]

Higher benefit "Franke et al., 2009"

Your opinion about "integrated configurators"

Please provide now your overall evaluation of the concept "integrated configurators" by answering to the following questions.

Compared to standard mobile phones, using a mobile phone with an integrated configurator would...

better satisfy my requirements.

very unlikely very likely

better meet my personal preferences.



more likely fit my image of a perfect mobile phone.



9 [Seiten-ID: 2716848] [L]

Intro Conjoint

Your preferred "Integrated Configurator" for mobile phones

In order to understand your preferences for "integrated configurators", you are kindly asked in the following part of the survey to make a hypothetical choice between alternative versions of an "integrated configurator" for mobile phones.

The version differ in their range of adaptable features (e.g. battery, MP3 player, navigation system, alarm clock, messages, calendar, calling etc.), in their degree of user friendliness and user support as well as in their terms and conditions.

Below is shown an **exemplary of choice situation**:

	Version A	Version B
Range of adaptable features & functions	20 adaptable features and functions	15 adaptable features and functions
User interface hardware	via mobile & computer	via mobile only
User interface software	graphical interface with drag and drop	some comand programming required
Instant test simulations	yes, test simulations possible	no, needs to be tested in action
User support by provider	online tutorials & direct user help desk	none
User support by online community	no online community	yes, online community available
Advertisements during usage	no advertising	with advertising
Data privacy	no, some personal data sold	yes, privacy ensured
Price	0.00 US\$	0.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?



10 [Seiten-ID: 2716881] [L]

Briefing

Your preferred "integrated configurator" for mobile phones

In the following, you will be confronted with **7 of these choice situations**. Every choice situation differs in the attributes you have seen before.

Please consider each of these choice situations independently and separately, i.e. compare the two versions of an "integrated configurator" for mobile phones within and not across choice situations. **Let's go!**

11.1.1 [Seiten-ID: 2716893] [L]

Szen_1

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	5 adaptable features and functions	10 adaptable features and functions
User interface hardware	via mobile only	via mobile & computer

User interface software	some comand programming required	graphical interface with drag and drop
Instant test simulations	no, needs to be tested in action	yes, test simulations possible
User support by provider	none	online tutorials
User support by online community	no online community	yes, online community available
Advertisements during usage	no advertising	no advertising
Data privacy	no, some personal data sold	yes, privacy ensured
Price	0.00 US\$	4.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A Version B None



11.1.2 [Seiten-ID: 2716982] [L]

Szen_2

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	15 adaptable features and functions	10 adaptable features and functions
User interface hardware	via mobile & computer	via mobile only
User interface software	some comand programming required	some comand programming required
Instant test simulations	yes, test simulations possible	yes, test simulations possible
User support by provider	direct user help desk	none
User support by online community	no online community	yes, online community available
Advertisements during usage	with advertising	with advertising
Data privacy	yes, privacy ensured	yes, privacy ensured
Price	4.99 US\$	0.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A Version B None



11.1.3 [Seiten-ID: 2716983] [L]

Szen_3

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	20 adaptable features and functions	5 adaptable features and functions
User interface hardware	via mobile only	via mobile only
User interface software	some comand programming required	graphical interface with drag and drop
Instant test simulations	no, needs to be tested in action	yes, test simulations possible
User support by provider	online tutorials & direct user help desk	online tutorials
User support by online community	yes, online community available	no online community
Advertisements during usage	no advertising	with advertising

Data privacy	no, some personal data sold	yes, privacy ensured
Price	4.99 US\$	2.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A **Version B** **None**

11.1.4 [Seiten-ID: 2716984] [L]
Szen_4

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	20 adaptable features and functions	10 adaptable features and functions
User interface hardware	via mobile only	via mobile & computer
User interface software	graphical interface with drag and drop	graphical interface with drag and drop
Instant test simulations	yes, test simulations possible	no, needs to be tested in action
User support by provider	none	online tutorials & direct user help desk
User support by online community	no online community	no online community
Advertisements during usage	with advertising	no advertising
Data privacy	yes, privacy ensured	yes, privacy ensured
Price	0.99 US\$	2.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A **Version B** **None**

11.1.5 [Seiten-ID: 2716986] [L]
Szen_5

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	10 adaptable features and functions	15 adaptable features and functions
User interface hardware	via mobile only	via mobile only
User interface software	graphical interface with drag and drop	some comand programming required
Instant test simulations	yes, test simulations possible	no, needs to be tested in action
User support by provider	online tutorials	online tutorials & direct user help desk
User support by online community	yes, online community available	yes, online community available
Advertisements during usage	no advertising	with advertising
Data privacy	yes, privacy ensured	yes, privacy ensured
Price	2.99 US\$	0.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A **Version B** **None**

11.1.6 [Seiten-ID: 2716987] [L]
Szen_6

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	15 adaptable features and functions	15 adaptable features and functions
User interface hardware	via mobile & computer	via mobile & computer
User interface software	graphical interface with drag and drop	graphical interface with drag and drop
Instant test simulations	yes, test simulations possible	yes, test simulations possible
User support by provider	online tutorials & direct user help desk	direct user help desk
User support by online community	no online community	no online community
Advertisements during usage	no advertising	with advertising
Data privacy	yes, privacy ensured	no, some personal data sold
Price	0.00 US\$	0.00 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A **Version B** **None**

11.1.7 [Seiten-ID: 2716988] [L]

Szen_7

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	5 adaptable features and functions	20 adaptable features and functions
User interface hardware	via mobile only	via mobile & computer
User interface software	some comand programming required	some comand programming required
Instant test simulations	no, needs to be tested in action	yes, test simulations possible
User support by provider	online tutorials	direct user help desk
User support by online community	yes, online community available	yes, online community available
Advertisements during usage	with advertising	no advertising
Data privacy	yes, privacy ensured	no, some personal data sold
Price	4.99 US\$	2.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A **Version B** **None**

11.2.1 [Seiten-ID: 2716990] [L]

Szen_1

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	5 adaptable features and functions	10 adaptable features and functions
User interface hardware	via mobile & computer	via mobile & computer
User interface software	graphical interface with drag and drop	graphical interface with drag and drop

Instant test simulations	yes, test simulations possible	no, needs to be tested in action
User support by provider	online tutorials	none
User support by online community	yes, online community available	no online community
Advertisements during usage	no advertising	with advertising
Data privacy	no, some personal data sold	no, some personal data sold
Price	4.99 US\$	4.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A Version B None



11.2.2 [Seiten-ID: 2716991] [L]

Szen_2

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	20 adaptable features and functions	20 adaptable features and functions
User interface hardware	via mobile & computer	via mobile only
User interface software	graphical interface with drag and drop	some comand programming required
Instant test simulations	no, needs to be tested in action	no, needs to be tested in action
User support by provider	online tutorials	none
User support by online community	no online community	yes, online community available
Advertisements during usage	with advertising	with advertising
Data privacy	no, some personal data sold	yes, privacy ensured
Price	0.00 US\$	2.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A Version B None



11.2.3 [Seiten-ID: 2716992] [L]

Szen_3

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	15 adaptable features and functions	20 adaptable features and functions
User interface hardware	via mobile only	via mobile only
User interface software	graphical interface with drag and drop	graphical interface with drag and drop
Instant test simulations	no, needs to be tested in action	yes, test simulations possible
User support by provider	direct user help desk	online tutorials
User support by online community	yes, online community available	yes, online community available
Advertisements during usage	no advertising	no advertising
Data privacy	yes, privacy ensured	no, some personal data sold
Price	0.00 US\$	4.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A Version B None

11.2.4 [Seiten-ID: 2716993] [L]

Szen_4

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	10 adaptable features and functions	15 adaptable features and functions
User interface hardware	via mobile only	via mobile & computer
User interface software	some comand programming required	graphical interface with drag and drop
Instant test simulations	yes, test simulations possible	yes, test simulations possible
User support by provider	none	online tutorials
User support by online community	no online community	yes, online community available
Advertisements during usage	with advertising	with advertising
Data privacy	no, some personal data sold	no, some personal data sold
Price	0.99 US\$	0.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A Version B None

11.2.5 [Seiten-ID: 2716994] [L]

Szen_5

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	15 adaptable features and functions	15 adaptable features and functions
User interface hardware	via mobile & computer	via mobile & computer
User interface software	some comand programming required	some comand programming required
Instant test simulations	no, needs to be tested in action	no, needs to be tested in action
User support by provider	online tutorials & direct user help desk	online tutorials & direct user help desk
User support by online community	yes, online community available	no online community
Advertisements during usage	with advertising	no advertising
Data privacy	no, some personal data sold	yes, privacy ensured
Price	0.99 US\$	0.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A Version B None

11.2.6 [Seiten-ID: 2716995] [L]

Szen_6

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	10 adaptable features and functions	5 adaptable features and functions
User interface hardware	via mobile & computer	via mobile & computer
User interface software	some comand programming required	graphical interface with drag and drop
Instant test simulations	no, needs to be tested in action	no, needs to be tested in action
User support by provider	direct user help desk	direct user help desk
User support by online community	no online community	yes, online community available
Advertisements during usage	no advertising	no advertising
Data privacy	yes, privacy ensured	yes, privacy ensured
Price	2.99 US\$	4.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A **Version B** **None**

11.2.7 [Seiten-ID: 2716996] [L]
 Szen_7

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	10 adaptable features and functions	10 adaptable features and functions
User interface hardware	via mobile & computer	via mobile only
User interface software	graphical interface with drag and drop	some comand programming required
Instant test simulations	yes, test simulations possible	yes, test simulations possible
User support by provider	direct user help desk	online tutorials & direct user help desk
User support by online community	yes, online community available	no online community
Advertisements during usage	with advertising	no advertising
Data privacy	no, some personal data sold	no, some personal data sold
Price	2.99 US\$	0.00 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A **Version B** **None**

11.3.1 [Seiten-ID: 2717000] [L]
 Szen_1

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	10 adaptable features and functions	10 adaptable features and functions
User interface hardware	via mobile & computer	via mobile & computer
User interface software	some comand programming required	graphical interface with drag and drop
Instant test simulations	no, needs to be tested in action	no, needs to be tested in action

User support by provider	online tutorials & direct user help desk	online tutorials
User support by online community	yes, online community available	yes, online community available
Advertisements during usage	with advertising	with advertising
Data privacy	yes, privacy ensured	no, some personal data sold
Price	0.00 US\$	0.00 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A **Version B** **None**



11.3.2 [Seiten-ID: 2717001] [L]

Szen_2

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	20 adaptable features and functions	15 adaptable features and functions
User interface hardware	via mobile & computer	via mobile only
User interface software	graphical interface with drag and drop	graphical interface with drag and drop
Instant test simulations	no, needs to be tested in action	no, needs to be tested in action
User support by provider	none	none
User support by online community	yes, online community available	no online community
Advertisements during usage	with advertising	no advertising
Data privacy	yes, privacy ensured	no, some personal data sold
Price	4.99 US\$	0.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A **Version B** **None**



11.3.3 [Seiten-ID: 2717002] [L]

Szen_3

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	15 adaptable features and functions	5 adaptable features and functions
User interface hardware	via mobile only	via mobile & computer
User interface software	graphical interface with drag and drop	some comand programming required
Instant test simulations	yes, test simulations possible	no, needs to be tested in action
User support by provider	online tutorials & direct user help desk	online tutorials
User support by online community	no online community	yes, online community available
Advertisements during usage	with advertising	no advertising
Data privacy	no, some personal data sold	no, some personal data sold
Price	2.99 US\$	4.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A Version B None

11.3.4 [Seiten-ID: 2717003] [L]

Szen_4

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	10 adaptable features and functions	15 adaptable features and functions
User interface hardware	via mobile & computer	via mobile & computer
User interface software	graphical interface with drag and drop	some comand programming required
Instant test simulations	yes, test simulations possible	yes, test simulations possible
User support by provider	direct user help desk	none
User support by online community	yes, online community available	yes, online community available
Advertisements during usage	no advertising	no advertising
Data privacy	no, some personal data sold	yes, privacy ensured
Price	0.99 US\$	2.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A Version B None

11.3.5 [Seiten-ID: 2717004] [L]

Szen_5

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	5 adaptable features and functions	20 adaptable features and functions
User interface hardware	via mobile only	via mobile only
User interface software	some comand programming required	graphical interface with drag and drop
Instant test simulations	yes, test simulations possible	no, needs to be tested in action
User support by provider	direct user help desk	direct user help desk
User support by online community	yes, online community available	no online community
Advertisements during usage	with advertising	with advertising
Data privacy	no, some personal data sold	yes, privacy ensured
Price	0.00 US\$	4.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A Version B None

11.3.6 [Seiten-ID: 2717005] [L]

Szen_6

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	20 adaptable features and functions	20 adaptable features and functions
User interface hardware	via mobile & computer	via mobile & computer
User interface software	some comand programming required	some comand programming required
Instant test simulations	no, needs to be tested in action	yes, test simulations possible
User support by provider	none	online tutorials & direct user help desk
User support by online community	no online community	no online community
Advertisements during usage	no advertising	with advertising
Data privacy	no, some personal data sold	no, some personal data sold
Price	2.99 US\$	4.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A **Version B** **None**

11.3.7 [Seiten-ID: 2717006] [L]
 Szen_7

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	5 adaptable features and functions	10 adaptable features and functions
User interface hardware	via mobile & computer	via mobile only
User interface software	graphical interface with drag and drop	graphical interface with drag and drop
Instant test simulations	no, needs to be tested in action	yes, test simulations possible
User support by provider	online tutorials	online tutorials & direct user help desk
User support by online community	no online community	yes, online community available
Advertisements during usage	no advertising	no advertising
Data privacy	no, some personal data sold	yes, privacy ensured
Price	0.99 US\$	0.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A **Version B** **None**

11.4.1 [Seiten-ID: 2717008] [L]
 Szen_1

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	5 adaptable features and functions	20 adaptable features and functions
User interface hardware	via mobile only	via mobile & computer
User interface software	graphical interface with drag and drop	some comand programming required

Instant test simulations	no, needs to be tested in action	no, needs to be tested in action
User support by provider	direct user help desk	online tutorials
User support by online community	no online community	no online community
Advertisements during usage	no advertising	with advertising
Data privacy	yes, privacy ensured	yes, privacy ensured
Price	4.99 US\$	0.00 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A Version B None

11.4.2 [Seiten-ID: 2717009] [L]

Szen_2

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	5 adaptable features and functions	15 adaptable features and functions
User interface hardware	via mobile & computer	via mobile only
User interface software	some comand programming required	graphical interface with drag and drop
Instant test simulations	yes, test simulations possible	yes, test simulations possible
User support by provider	online tutorials	online tutorials
User support by online community	no online community	no online community
Advertisements during usage	with advertising	no advertising
Data privacy	yes, privacy ensured	yes, privacy ensured
Price	2.99 US\$	2.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A Version B None

11.4.3 [Seiten-ID: 2717010] [L]

Szen_3

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	20 adaptable features and functions	10 adaptable features and functions
User interface hardware	via mobile only	via mobile & computer
User interface software	some comand programming required	some comand programming required
Instant test simulations	yes, test simulations possible	yes, test simulations possible
User support by provider	online tutorials	none
User support by online community	yes, online community available	no online community
Advertisements during usage	no advertising	no advertising
Data privacy	yes, privacy ensured	yes, privacy ensured
Price	0.00 US\$	0.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A Version B None

11.4.4 [Seiten-ID: 2717011] [L]

Szen_4

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	20 adaptable features and functions	20 adaptable features and functions
User interface hardware	via mobile only	via mobile only
User interface software	some comand programming required	graphical interface with drag and drop
Instant test simulations	yes, test simulations possible	no, needs to be tested in action
User support by provider	online tutorials & direct user help desk	direct user help desk
User support by online community	no online community	yes, online community available
Advertisements during usage	no advertising	no advertising
Data privacy	no, some personal data sold	no, some personal data sold
Price	4.99 US\$	0.00 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A Version B None

**11.4.5** [Seiten-ID: 2717012] [L]

Szen_5

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	15 adaptable features and functions	5 adaptable features and functions
User interface hardware	via mobile & computer	via mobile only
User interface software	some comand programming required	some comand programming required
Instant test simulations	yes, test simulations possible	no, needs to be tested in action
User support by provider	none	online tutorials & direct user help desk
User support by online community	yes, online community available	yes, online community available
Advertisements during usage	no advertising	with advertising
Data privacy	yes, privacy ensured	no, some personal data sold
Price	0.99 US\$	2.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A Version B None

**11.4.6** [Seiten-ID: 2717013] [L]

Szen_6

Your preferred "integrated configurator" for mobile phones**Version A****Version B**

Range of adaptable features & functions	10 adaptable features and functions	5 adaptable features and functions
User interface hardware	via mobile only	via mobile only
User interface software	graphical interface with drag and drop	some comand programming required
Instant test simulations	no, needs to be tested in action	yes, test simulations possible
User support by provider	online tutorials & direct user help desk	direct user help desk
User support by online community	no online community	no online community
Advertisements during usage	with advertising	with advertising
Data privacy	yes, privacy ensured	no, some personal data sold
Price	0.99 US\$	4.99 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A **Version B** **None**

11.4.7 [Seiten-ID: 2717014] [L]
 Szen_7

Your preferred "integrated configurator" for mobile phones

	Version A	Version B
Range of adaptable features & functions	15 adaptable features and functions	5 adaptable features and functions
User interface hardware	via mobile only	via mobile & computer
User interface software	graphical interface with drag and drop	graphical interface with drag and drop
Instant test simulations	no, needs to be tested in action	yes, test simulations possible
User support by provider	none	direct user help desk
User support by online community	yes, online community available	yes, online community available
Advertisements during usage	with advertising	with advertising
Data privacy	no, some personal data sold	yes, privacy ensured
Price	2.99 US\$	0.00 US\$

Which of the two versions of an "integrated configurator" for mobile phones would you choose in this situation?

Version A **Version B** **None**

12 [Seiten-ID: 2706121] [L]
 Assessment of your mobile phone

Assessment of your current mobile phone

In this part of the survey you are kindly asked to provide your overall evaluation of your current mobile phone by commenting on the following statements.

For my mobile phone, I chose an individual combination of features.

strongly disagree strongly agree

When buying my mobile phone, I paid special attention to certain features that meet my preferences.

strongly disagree strongly agree

I try to customize my current mobile phone, so that it would exactly fulfill my individual needs.

strongly disagree strongly agree

My current mobile phone is almost identical and unaltered compared to the standard or base model.

strongly disagree strongly agree

My current mobile phone has a large number of features.

strongly disagree strongly agree

The features of my current mobile phone perform many functions.

strongly disagree strongly agree

My current mobile phone has many capabilities.

strongly disagree strongly agree

13 [Seiten-ID: 2706122] [L]

Assessment of your mobile phone part 2

Assessment of your current mobile phone

It is easy to get my mobile phone and all its features to do what I want them to do.

strongly disagree strongly agree

My mobile phone contains too many irrelevant features that are not of interest to me.

strongly disagree strongly agree

Many features of my mobile phone are basically useless to me.

strongly disagree strongly agree

Using certain features of my mobile phone is often difficult and exhausting.

strongly disagree strongly agree

My mobile phone is one of the best mobile phones I could have bought.

strongly disagree strongly agree

My mobile phone has not worked out as well as I thought it would.

strongly disagree strongly agree

I am not happy that I bought this mobile phone.

strongly disagree strongly agree

I am sure it was a right decision to buy this mobile phone.

strongly disagree strongly agree

14 [Seiten-ID: 2706123] [L]

User experience about mobile phone

Your experience concerning mobile phone

In this last part of the survey you are kindly asked to give your overall evaluation about your own experience concerning mobile phone by commenting on the following statements.

I rarely come across mobile phones that I have not heard of.

strongly disagree strongly agree

Among my circle of friends, I am one of the "experts" on mobile phones.

strongly disagree strongly agree

I feel quite knowledgeable about mobile phones.

strongly disagree strongly agree

My preferences concerning mobile phone features and characteristics constantly change.

strongly disagree strongly agree

I often have changing or even new requirements for my mobile phone.

strongly disagree strongly agree

Regarding mobile phones, I know exactly what I want.

strongly disagree strongly agree

When I purchase a mobile phone, I usually know quite soon what I prefer.

strongly disagree strongly agree

When I purchase a mobile phone, I find it easy to choose among different alternatives.

strongly disagree strongly agree

I have already made significant modifications and innovations to my mobile phone on my own.

strongly disagree strongly agree

I seek out new ways to do things on my mobile phone.

strongly disagree strongly agree

I frequently improve methods on my mobile phone for solving a problem when an answer is not apparent.

strongly disagree strongly agree

15 [Seiten-ID: 2741978] [L]

User experience part 2

For me, always having the latest news in mobile phone is ...

unimportant important
useless useful
nonessential essential

I am generally more likely to buy a mobile phone if it is rare.

strongly disagree strongly agree

In general, I enjoy having things for my mobile phone that others do not.

strongly disagree strongly agree

I can easily explain to someone else what kind of mobile phone I like best.

strongly disagree strongly agree

It is not a problem for me to name those attributes of a mobile phone which are the most important to me.

strongly disagree strongly agree

If I have three minutes´ time to explain to someone else what I like and what I dislike, this person can theoretically choose a mobile phone for me that meets my requirements.

strongly disagree strongly agree

In general, I am among the last of my circle of friends to buy a new mobile phone when it appears.

strongly disagree strongly agree

I will buy a new mobile phone, even if I have not heard of it yet.

strongly disagree strongly agree

I know the name of a new mobile phone before other people do.

strongly disagree strongly agree

16 [Seiten-ID: 2706124] [L]

Questions about the participants

Concluding questions about you.

How old are you?

years

What is your gender?

male

female

Please enter your educational level.

College or Technical School Graduate

Graduate School

High School Graduate

Some College or Technical School

Some High School

What is your total household income?

Less than \$10,000

\$10,000 to \$19,999

\$20,000 to \$29,999

\$30,000 to \$39,999

\$40,000 to \$49,999

\$50,000 to \$59,999

\$60,000 to \$69,999

\$70,000 to \$79,999

\$80,000 to \$89,999

\$90,000 to \$99,999

\$100,000 to \$149,999

\$150,000 or more

17 [Seiten-ID: 2706126] [L]

Endseite

Thank you very much for your participation!

If you have any questions or if you need help, feel free to contact Mrs. Morgane Benade at any time:

benade@tim.rwth-aachen.de

Résumé

Au cours de la dernière décennie, les technologies de l'information et de la communication intégrées aux produits de consommation ont considérablement modifié la nature de leurs usages. Réactives, les entreprises se sont emparées de ces nouvelles technologies et proposent aux consommateurs de customiser leurs produits quotidiens après achat. J'ai intitulé cette approche "Smart Customization", dans ma thèse. L'idée étant que, pour qu'une telle customisation "intelligente" ait lieu, il faut intégrer directement des boîtes à outils intelligentes (ou smart UTCD) dans nos produits de consommation. Ces boîtes à outils intelligentes sont ensuite destinées à guider les consommateurs dans le procédé de customisation de leurs objets. Actuellement, il n'y a pas véritablement de recherche académique alors que, au contraire, la presse industrielle évoque la smart customization comme une opportunité à exploiter. Il semble pourtant essentiel, d'identifier les facteurs de succès de ces nouvelles offres de customisation, notamment, en adoptant le point de vue du consommateur sur l'élément principal Smart UTCD. C'est ce qui a déterminé l'objectif de ma thèse. Via une étude d'acceptance technologique dans le papier 1, un choice-based conjoint analysis dans l'article 2 et une exploration des mécanismes de co-conception qui ont lieu entre le consommateur et l'outil de conception « smart UTCD », je participe à la recherche sur la smart customisation.

Mots Clés

Boîtes à Outils d'Aide aux Co-design, Smart Customization, Co-création

Abstract

In the last decade, our products have been more and more equipped with information and communication technology (ICT), which has modified the nature of their applications greatly. Notably, firms find finally a mean to empower customers to customize their products after purchase. One talks about "Smart Customization". For such "smart" customization to happen, the idea is to embed directly smart user toolkits for co-design (smart UTCD) into our consumer products. That said, while in the business press, they largely view smart customization as an opportunity to be tapped, in contrast, research is hardly focused on it. Notably, it appears essential to identify factors of customer - based success of such novel customization offers. Thereby, in paper I, I adapt and test a technology acceptance model to smart UTCD. In paper II, I realize a choice based conjoint analysis on smart UTCD. In article III, I expose a theoretical framework for use generation and apply it on the two existing types of smart UTCD. With my findings, I contribute to theory by adding to our limited understanding of the smart UTCD acceptance, providing in-depth knowledge on the customer's choice process on the smart UTCD design features and by opening the black box on the co-design mechanisms that occur between customers - smart UTCD. Additionally, the findings of my three articles that compose my dissertation permit firms to be provided with some measures on how to design smart customization offers that fit better the target customers.

Keywords

User Toolkits for Co-design, Smart Customization, Co-creation with a Lay Person