THE ROLES OF FORM AND FUNCTION IN UTILITARIAN MOBILE DATA SERVICE DESIGN

Achim Botzenhardt
Institute for Enterprise Systems (InES)
University of Mannheim,
68161 Mannheim, Germany
achim.botzenhardt@es.uni-mannheim.de

Ye Li
Institute for Enterprise Systems (InES)
University of Mannheim,
68161 Mannheim, Germany
ye.li@es.uni-mannheim.de

Alexander Maedche
Institute of Information Systems and Marketing (IISM)
Karlsruhe Service Research Institute (KSRI)
Karlsruhe Institute of Technology (KIT)
76131 Karlsruhe, Germany
and
Institute for Enterprise Systems (InES)
University of Mannheim,
68161 Mannheim, Germany
alexander.maedche@kit.edu

ABSTRACT

Mobile devices, as well as mobile data services (MDS), have become powerful aids in our daily life. Starting with simple communication services, MDS now offer a solution for almost every private and business life demand. The market for MDS has become very competitive, and continuously increasing consumer demands are putting pressure on MDS providers. Recently, the design of mobile devices and services has received much attention, since it provides vast opportunities for differentiating offerings and for gaining a competitive advantage. However, the concrete application of design often leads to semantic confusion. Based on Wixom and Todd's [2005] theoretical integration of user satisfaction and technology acceptance, and by conceptualizing form and function as the two major components of design, we propose a theoretical model that specifically investigates which MDS design characteristics influence users' satisfaction and, subsequently, their behavioral intention. We tested our model empirically by means of partial least square (PLS) analysis, using a sample of 2,295 responses from utilitarian MDS users in the mobile banking context. The findings reveal that both components of design – form and function – were positively associated with satisfaction. MDS consumer age and the MDS usage frequency moderated the relationship between form and satisfaction.

Keywords: Utilitarian mobile data service; Mobile banking; Design; Form and function; Satisfaction

1. Introduction

Mobile data services (MDS), which can be defined as "an assortment of digital data services that can be accessed using a mobile device over a wide geographic area" [Hong and Tam 2006], have become pervasive in our lives. They are normally accessed via mobile applications or mobile websites [Ketkar, Shankar and Banwet 2012; Cortimiglia, Ghezzi, and Renga 2011; Nah et al. 2005]. BDS can be conceptualized in two ways, depending on the perspective taken [Choi et al. 2007]. In a narrow view, MDS specifically refer to data services accessed through a mobile communication network (e.g. GPRS, GSM, LTE). From a broader perspective, MDS "refer to the convergence of mobile communications and the Internet, and thus includes any access to the Internet through wireless connections" [Choi et al. 2007], which include Wi-Fi connections. MDS include a variety of digital data services, which can be

divided into utilitarian ones (e.g. news, navigation, or mobile banking services) and hedonic ones (e.g. mobile games, or audio/video entertainment players) [Kim and Han 2011]. Our study follows the broader conceptualization, confining itself to utilitarian MDS accessed via smartphones, tablet devices, mobile applications, and mobile websites.

Over the course of time, MDS have developed substantially, starting from a low-end wireless application protocol (WAP) in 1997 to the recently developed and very flexible multiplatform and multidevice applications. The advent of mobile devices and the rapid growth of technological innovations, through which an increasing number of usage scenarios became possible, triggered the evolution of MDS [Cortimiglia et al. 2011]. After a slow start, the past five years have seen the massive adoption of mobile devices and mobile data services. Smartphone penetration in Europe was expected to reach nearly half of the population by the end of 2013, and tablet ownership in Western Europe was set to quadruple in the next five years [Husson and Reitsma 2013]. Simultaneously, the global penetration of mobile Internet users was expected to exceed PC-based Internet users by 2016 [Huynh and Wray 2012]. While MDS could at first only retrieve emails, they can now meet many private or business demands, and innovation is ongoing [Hong and Tam 2006]. MDS provide ubiquitous access to real-time information and B2C/B2B transactions from almost any place and from multiple devices (e.g. smartphones, tablets, and hybrid devices) [Cortimiglia et al. 2011; Lee et al. 2009]. This paradigm shift towards high mobile use massively impacts many industries. Above all, the software industry has undergone substantial changes and has shown tremendous growth rates in terms of the development of mobile offerings, which industries such as IT, banking, and retail are widely adopting [Accenture 2013]. Along with the improved capabilities of MDS, customer demands are increasing. They expect anytime, anywhere access to services, and with any device, which should also be easy to use and appealing [Maedche et al. 2012].

Against this background, design is becoming increasingly important as well as a key to product success [Candi and Saemundsson 2011; Hertenstein et al. 2005]. Design can serve as a tactical and strategic tool by which firms can achieve competitive advantage by differentiating their offerings [Luchs and Swan 2011]. Companies increasingly face the challenge of delivering well-designed MDS. However, many companies are struggling to clearly define this multifaceted term [Lawson and Dorst 2009]. A reason for this problem is the ambiguity of the term design, which can be a verb or a noun and thus represent either a process, or an outcome perspective. Here, we take an outcome perspective, since we examine a specific software artifact: mobile data services.

While there is no commonly accepted definition [Luchs and Swan 2011], there is agreement that design can be divided into two fundamental components: form and function [Townsend, Montoya, and Calantone 2011; Ulrich and Eppinger 2012]. Function refers to certain product function characteristics and their perceived performance, while form refers to certain customer interface characteristics and is often addressed from the perspective of visual aesthetics [Townsend et al. 2011].

Despite the growing importance of design as a key to competitive advantage, very little research has addressed design from the outcome perspective, in terms of its form or function, in the context of MDS [Lee and Benbasat 2003]. Most MDS studies focus on adoption [Hong and Tam 2006; López-Nicolás et al. 2008; Al-Jabri and Sohai 2012; Yu 2012], post-adoption usage [Chea and Luo 2008; Chen et al. 2012; Kim et al. 2008; Lee et al. 2009; Thong et al. 2006], or customer loyalty [Cyr et al. 2006; Lim et al. 2006; Lin and Wang 2006] as dependent variables without specifically including design as an independent variable. One of the most comprehensive MDS studies – that of Hong and Tam [2006] – investigates the influence of different adoption drivers, along five categories: technology-specific perceptions, general technology perceptions, demographics, social influence, and user psychographics. However, they neglected design as an adoption driver.

Cyr, Head, and Ivanov [Cyr et al. 2006] conducted one of the few studies that explicitly includes design and that shows that visual aesthetics positively influence individuals' perceived usefulness (PU), perceived ease of use (PEOU), and enjoyment of a mobile service. This influence subsequently leads to individuals' loyalty to the mobile service. Further, Li and Yeh [2010] investigated and verified visual aesthetics' influence on individuals' beliefs about using a mobile commerce website (in terms of its perceived usefulness, ease of use, and customization) and the subsequent impacts on those individuals' trust in that m-commerce website. However, both studies address only a single component of design in a specific setup, thereby neglecting design's complexity, as well as different device types (e.g. smartphones and tablets), or service delivery types (e.g. native apps and mobile websites). There is no holistic view of design that considers both design components (form and function) and technological innovations such as multiplatform applications and multiple devices. Addressing these knowledge gaps, we examine design's pivotal role in the context of utilitarian MDS. Specifically, we address the following research question:

How do form and function influence satisfaction with utilitarian MDS?

Our conceptual foundation is based on the theoretical integration of user satisfaction and Wixom and Todd's [2005] technology acceptance. These authors explicitly distinguish between object-based beliefs and attitudes found in the user satisfaction literature and behavioral beliefs and attitudes in the technology acceptance literature. The object-based part thus represents beliefs and attitudes about the system, while the behavioral part refers to beliefs and

attitudes about using the system. We refer to this theory as Wixom and Todd's integrative theory throughout this paper. We share these authors' understanding that perceptions of IS success can be addressed from the user satisfaction and/or technology acceptance perspectives.

The remainder of this paper is structured as follows: In Section 2, we outline the study's theoretical background and introduce the research model. The latter comprise the two central design components (form and function) and their impact on satisfaction and, subsequently, on behavioral intention (BI). In Section 3, we provide an overview of the research methodology. In Section 4, we illustrate the research results. In Section 5, we discuss the results. Section 6 concludes the paper, and describes its contributions and limitations, as well as possible future research opportunities arising from it.

2. Theoretical Background and Model Development

2.1 Technology Acceptance and Satisfaction

There is a long tradition in information systems (IS) research that follows a belief-based paradigm according to which individuals' beliefs in a system's capabilities and performance (e.g. usefulness or reliability) are associated with its subsequent behaviors [Wixom and Todd 2005]. Many theories have been developed and applied to understand information systems' acceptance and success in terms of satisfaction and usage. Several well-known theories have emerged, including the technology acceptance model (TAM) [Davis 1989] and the IS success model [DeLone and McLean 1992, 2003].

Of these, TAM – which uses PU and PEOU to predict an individual's intention to use a system – is probably the most-cited and commonly employed theory in IS research to date [Lee et al. 2003]. Over the past decades, there were numerous adaptations and extensions of, and successors to, TAM [Venkatesh and Bala 2008; Venkatesh and Davis 2000; Venkatesh et al. 2003]. However, TAM is subject to a wide range of criticism [Bagozzi 2007; Benbasat and Barki 2007], because it limits researchers' attention with its simplified view of decisions and behavior, thereby neglecting other important aspects of IS research, such as artifact design [Benbasat and Zmud 2003]. Since TAM treats the system artifact as a 'black box', and it only assesses the artifact's perceived usefulness and perceived ease of use, what in fact makes a system useful or easy to use remains unexplained [Benbasat and Barki 2007]. The often-employed IS success model [DeLone and McLean 1992, 2003, 2004] addresses this issue by placing greater emphasis on system artifact features.

These two theories were long treated in isolation and developed independently. Wixom and Todd's integrative theory [2005] made a major contribution to breaking down this division between user satisfaction and technology acceptance. By including information quality and system quality [DeLone and McLean 1992; Seddon 1997] as antecedents of satisfaction, Wixom and Todd's model fosters understanding of how artifact design influences satisfaction and, subsequently, adoption. Recently, Xu, Benbasat, and Cenfetelli [Xu et al. 2013] validated and extended Wixom and Todd's [2005] original model by including a service quality dimension. However, although they focus on functional system characteristics, both studies neglect, in terms of visual aesthetics, another increasingly important object-based belief: the design component of form. The consideration of form in terms of visual aesthetics is of great relevance, since visual aesthetics has been shown to critically affect satisfaction [Moshagen and Thielsch 2010]. To fully leverage the power of design, it is important to consider the design construct's complexity, a deep understanding of form and function, as well as their subsequent impact on satisfaction. Venkatesh and Bala [2008] further highlighted that "it is important to drill down into what design characteristics influence what specific aspects of perceived usefulness and perceived ease of use in order to enhance our ability to identify and improve specific design characteristics" [p. 294]. We answer this call for research, and seek to open this 'black box' by investigating the specific MDS design characteristics that influence users' satisfaction and subsequently behavioral intention. Building on Wixom and Todd's [2005] integrative theory, we develop and evaluate a theoretical model that specifically addresses the two central design components form and function at an individual technology usage level in the context of a utilitarian MDS: mobile banking services (MBS).

2.2 Design – Form and Function

Defining design is a non-trivial task, mainly owing to its multifaceted nature [Lawson and Dorst 2009]. To date, there is no commonly accepted definition [Luchs and Swan 2011]. However, it is widely acknowledged that design comprises two fundamental components: form and function [Hauser, Tellis, and Griffin 2006; Hollins and Pugh 1990; Kotler and Rath 1984; Oakley 1990; Townsend et al. 2011; Ulrich and Eppinger 2012; Urban and Hauser 1993]. This is also reflected in the seminal work by Luchs and Swan [2011] on design's emergence in the field of marketing. By summing up the research insights of the past decades, Luchs and Swan [2011] define design as "the set of properties of an artifact, consisting of the discrete properties of the form (i.e. the aesthetics of the tangible good and/or service) and the function (i.e. its capabilities) together with the holistic properties of the integrated form and function" [p. 338]. Building on this definition, we conceptualize form and function as the two major components of design. We will now

briefly outline our understanding of each component and will illustrate the corresponding composition in terms of our study.

2.2.1 Function

The function component has its roots in engineering design [Veryzer 1993], with its focus on certain product function characteristics, which lead to an increased perceived utility. Townsend, Montoya, and Calantone [2011] further state that these product function characteristics "refer to design capabilities that arrange objects in such a way that people can use them more efficiently and comfortably" [p. 376]. In the MDS literature, this performance perspective is captured in the system quality construct, as "the customer's perception of MDS performance in terms of information retrieval and delivery" [Kim and Han 2011, p. 2312]. Similarly, in a recent study on MDS, Lee, Shin, and Lee [2009] define system quality as "a person's general perception of MDS in terms of software and hardware performance and can be a second-order construct reflected by various system features" [p. 866]. We share this understanding and suggest that system quality is an adequate conceptualization of the function component of design.

To identify appropriate measurements of system quality, we conducted an extensive review of the IS literature, which contains a wide range of indicators of system quality. However, all are not equally important in the context of our MDS study, since many of the measurements of system quality refer to former mainframe and PC-based technologies, and are therefore not suitable for mobile web technologies and applications [Aladwani and Palvia 2002; Lee et al. 2009]. Based on the insights from our review, we derived accessibility, timeliness, and flexibility as salient dimensions in the context of our study, owing to their relevance and their rigorous validation in the IS literature [Kim and Han 2011; Lee et al. 2009; McKinney, Yoon, and Zahedi 2002; Xu et al. 2013]. It must be noted that while the selection is not necessarily exhaustive, it is considered highly suitable for the context of mobile web technologies and applications. System quality's role in an IT service's success has been investigated in several contexts, and numerous studies have shown the relationship between the system quality and user satisfaction [McKinney et al. 2002; Petter et al. 2008; Seddon 1997]. Thus, we predict that:

H1: Perceived system quality positively influences user satisfaction in a utilitarian MDS context.

2.2.2 Form

In contrast, the product form component emerged from the industrial design domain, where the primary focus is enhancing the customer-product interface by following a user-centric and aesthetic perspective [Hertenstein et al. 2005; Townsend et al. 2011]. A set of elements thereby determines the product form in terms of specific structural characteristics, such as shape or proportion, and visual characteristics such as color(s), which an industrial designer selects and combines in order to evoke a particular consumer response [Bloch 1995; Crilly et al. 2004; Rindova and Petkova 2007]. According to Luchs and Swan [2011], product form is "typically addressed from the point of view of visual aesthetics" [p. 342], which is a well-researched construct derived from the human-computer interaction (HCI) domain [Lavie and Tractinsky 2004]. Early studies tended to measure visual aesthetics with a single-item measurement, or a few generic and globally formulated items [Cyr et al. 2006; van der Heijden 2003; Li and Yeh 2010; Lindgaard and Dudek 2003; Loiacono et al. 2007]. These studies overlooked significant subdimensions of visual aesthetics. Although appropriate for a quick assessment, these measurements are not suitable for our study, since we explicitly consider the design construct's complexity, a deep understanding of form and function, as well as their subsequent impact on satisfaction and behavioral intention.

Recent research [Moshagen and Thielsch 2010, 2012] has introduced a comprehensive and validated multidimensional instrument to assess the visual aesthetics of websites by means of four interrelated facets. First, simplicity refers to structure, clarity, harmony, and other aspects of a layout, which enables easy perception and the mental processing of a website. Second, diversity addresses aspects that reflect a dynamic, varied, and inventive layout. Third, colorfulness determines whether the mixture of colors is attractive. Fourth, craftsmanship comprises items addressing the layout and the extent to which a website appears professionally designed. Since the instrument has been proved to soundly assess the complex construct of visual aesthetics in various studies [Moshagen and Thielsch 2010], we adopted it for our study.

An appropriate product form can lead to numerous positive outcomes, and aesthetic sensibilities are "relevant to all products, regardless of their function" [Bloch 1995]. Extant studies indicate a positive association between visual aesthetics and user satisfaction in other context setups [Cyr 2008; Lindgaard and Dudek 2003; Tractinsky et al. 2000; Zhang and von Dran 2000]. Thus, we predict that:

H2: Perceived visual aesthetics positively influences user satisfaction in a utilitarian MDS context.

Furthermore, prior studies suggest that the effects of form and function on user perceptions are contingent on various factors [Bloch et al. 2003; Bloch 1995; Hoyer and Stokburger-Sauer 2012; Tractinsky 2004, 2006]. The literature provides a vast amount of potential moderators that can influence consumers' attitudinal or behavioral consequences (e.g. satisfaction and adoption) owing to their perceptions of an IT artifact's specific design characteristics [Tractinsky 2004]. Thus, we identified a set of moderating variables to gain a deeper understanding of the effects of form and function. Following Tractinsky's [2006] proposed categories of potentially important moderators, we examined the effects of individual differences, the degree of experience with, and exposure to, the system, and type of system used [pp. 339-340].

The first category relates to MDS users' individual differences regarding their demographics, specifically their age and gender. Previous research in the consumer research and design field has suggested that the assessment of attractiveness usually differs according to consumer age [DeLong 1987]. For instance, the effects of visual attributes and consumer characteristics have been investigated in the context of product design, [Eckmann and Wagner 1994]. Holbrook and Schindler [1989] specifically found that age is positively related to preferences for music as an aesthetic product. Furthermore, gender's moderating effects on user satisfaction have also been researched. Recent work by Zhou et al. [2014] explored gender's moderating role on the relationships between perceived benefits and satisfaction in the context of social virtual world continuance. In their work, these authors find that female users react to utilitarian and social benefits more favorably than males do and that, in contrast, a hedonic benefit has a more salient effect on males' satisfaction.

The second category relates to an individual's experience and usage frequency concerning MDS. Previous research on customer satisfaction has shown that frequency of use is negatively related to overall satisfaction [Shankar et al. 2003]. This can be explained by the fact, that more frequent users generally also having higher expectations and being less likely to be satisfied than infrequent users. Furthermore, previous research identified a positive relationship between the number of years an individual has experienced a digital service and the associated user satisfaction [Mahmood et al. 2000].

The third and more domain-specific or context-specific category relates to the system type individuals use to receive MDS. This is either a smartphone or a tablet, while the service delivery type is either a mobile website (e.g. in HTML5) or a native app installed on the mobile device. Thus, we propose that:

H3: The relationship between perceived system quality and user satisfaction in a utilitarian MDS context is moderated by a) age, b) gender, c) usage frequency, d) experience, e) device type, and f) service delivery type.

H4: The relationship between perceived visual aesthetics and user satisfaction in a utilitarian MDS context is moderated by a) age, b) gender, c) usage frequency, d) experience, e) device type, and f) service delivery type.

2.2.3 Theoretical Model

Drawing on the insights gained from Wixom and Todd's [2005] integrative theory and the findings of related studies in the MDS context (i.e. mobile banking), we propose a theoretical model that specifically considers an IT artifact's design characteristics by means of a twofold perspective of design (in terms of form and function). In contrast to Wixom and Todd's [2005] original model, we mention four specific characteristics of our theoretical model. First, Wixom and Todd conducted their study with data warehouse users in a business – and therefore mandatory – environment. Our study is of a voluntary nature, since we approached mobile banking users in a non-business environment. Second, we did not include attitudes to using technology as a construct in our model. This is common practice in non-mandatory environments [Brown et al. 2002], since several studies have shown that there is no additional value when including the mediating attitude construct [Davis and Venkatesh 1996; Venkatesh and Davis 2000; Venkatesh 1999]. Therefore, we decided to exclude the attitude construct in order to foster our model's parsimony. Third, since we pursued a drill-down on specific artifact design components, we did not include other classical quality dimensions of IS success, such as information quality and service quality. This does not necessarily mean that these other quality dimensions are not important; they may be included in a holistic evaluation approach, rather than focusing on specific artifact design components and on individual-level technology usage, as our study does. Fourth, because this study investigates the effects of form and function (that is, beyond the system quality), we focused on user satisfaction instead of system satisfaction.

In accordance with Wixom and Todd [2005], we further hypothesize that satisfaction is linked to perceived usefulness and perceived ease of use. The remaining hypotheses concerning PU, PEOU, and BI are equivalent to the

classic TAM [Davis 1989], and have been shown to hold true in numerous studies in different context setups. Therefore, we adopted them. The overall theoretical model is presented in Figure 1.

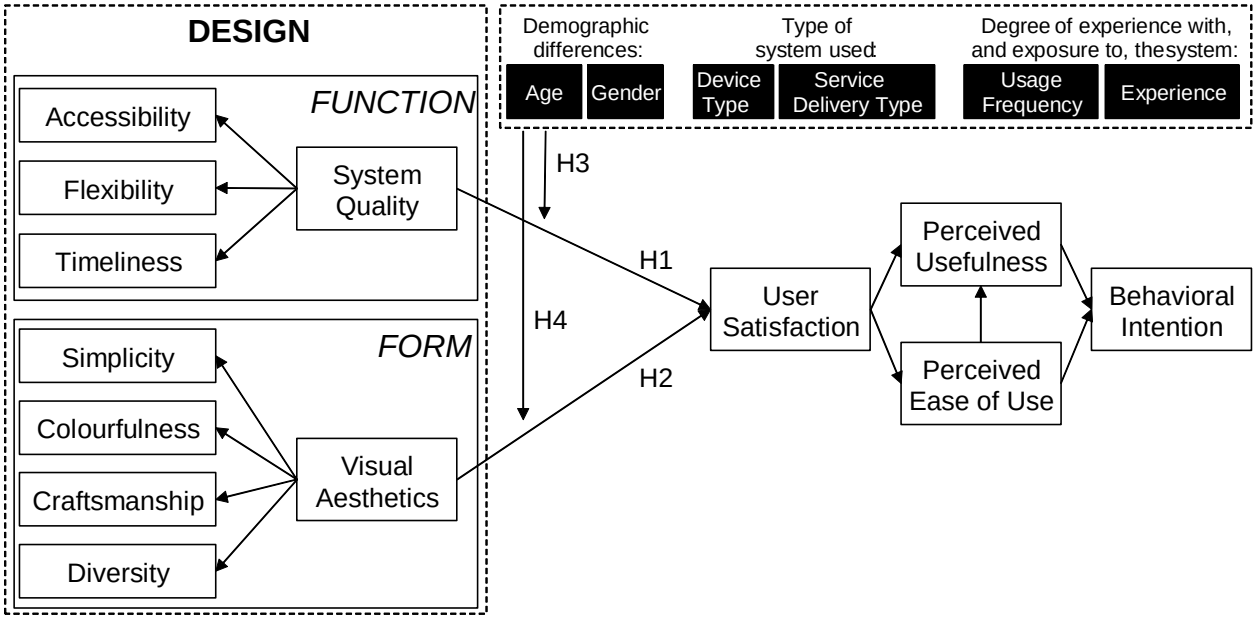

Figure 1. Research Model

3. Research Methodology

We employed a web-based survey to empirically assess our conceptual model. This data collection method was preferred to a paper-based survey, because it enables economical and swift data collection from a large representative sample [Dillman et al. 2008]. The method also supports real-time tracking of the response rate and in-time follow-up on non-respondents during the data collection phase [Dillman et al. 2008]. Nonetheless, a web-based survey can only reach respondents with access to the Internet, which may lead to a sampling bias [Wright 2006]. We consider sampling bias to be a low risk in this study, since the targeted respondents were mobile data services users, who are a subsample of Internet users.

The process of building the questionnaire was divided into four steps. First, we reviewed the literature for existing construct operationalization. We extracted valid and reliable measures of the key constructs from previous studies and incorporated them into our research model. Appendix 2 provides a detailed list of all constructs and items. We derived the items measuring the timeliness, accuracy, and the flexibility of the second-order construct system quality from Wixom and Todd [2005] and Lee et al. [2009]. For the visual aesthetics construct, we adopted the items from Moshagen and Thielsch [2010]. We drew the items perceived ease of use and perceived usefulness from Wixom and Todd [2005] and Hong and Tam [2006]. We adapted the measurement items for behavioral intention from Venkatesh et al. [2003]. To measure user satisfaction, we adopted the original scale by Spreng, MacKenzie, and Olshavsky [1996]. Following these authors' definition, we understand user satisfaction as "an affective state that is the emotional reaction to a product or service experience" [1996, p. 17]. This affective state is based on a summary evaluation of the entire usage experience of a certain product or service. In a second step, we translated the conceptualizations into German. We followed a back-translation approach to ensure the correct translation of the original items [Brislin 1986]. Furthermore, we undertook a slight rewording to suit the study's mobile banking context. Next, we conducted two group discussions with IS, marketing, and design experts to examine the understandability and relevance of the survey content and terminology consistency. Any detected ambiguity was resolved. Third, based on the gained insights, we drafted a questionnaire for pretesting. At the end of the survey, we added two additional open-ended questions to capture qualitative feedback relating to the most important characteristics, as well as the most disrupting characteristics of the mobile banking services. In a last step, we conducted a pretest with 83 participants. This sample comprised German students and employees aged between 20 and 61. The sample comprised an almost equal number of males and females. We then made minor changes to the questionnaire and its appearance.

The final questionnaire setup was as follows: At the start, we provided the respondents with a definition of mobile banking, emphasizing the difference between two possible mobile devices: smartphones and tablets. We refer to mobile banking as a utilitarian MDS that includes all banking activities performed on a tablet or smartphone via a

mobile application or a mobile website. In addition, we provided examples of each mobile device type. Next, we asked the respondents about their average mobile banking usage frequency. Were filtered out those who stated that they had never done mobile banking on their mobile devices, in order to maintain response accuracy and integrity.

We employed a professional online research panel provider that actively recruits online access panels for the formal test. The online survey was spread across all age segments above 18 and gender groups in the group of tablet and smartphone users in Germany. The data were gathered over three weeks. We received a sample of n = 2,295 mobile banking users. Through this approach, we reached a fairly representative sample of Germany's banking landscape (including third-party mobile banking solutions providers), instead of a constrained sample of a few users. Table 1 provides an overview of the descriptive statistics of the mobile banking users.

Table 1. Descriptive Statistics of the Mobile Banking Users

Demographics		**Freq. (%) n = 2,295)**	**Demographics**		**Freq. (%) n = 2,295**	**Demographics**		**Freq. (%) n = 2,295**
Gender	Female	54.1	Device	Smartphone	78.5	Service delivery	Native app	43.9
	Male	45.9		Tablet	21.5		Mobile web	56.1
Age	< 20	3.0	Usage frequency	Once a month	23.4	Experience	≤ 1 month	9.2
	20 to 29	31.3						
	30 to 39	24.8		Multiple times per month	36.5		≤ 6 months	34.5
	40 to 49	21.3						
	50 to 59	13.5		Weekly	28.5		≤ 1 year	30.7
	≥ 60	6.1		Daily	11.6		> 1 years	25.6

To reduce non-response bias, the panel provided incentives and sent out reminders to potential respondents during the data collection [King and He 2005]. After the data collection, we examined the potential non-response bias by comparing the early and the late respondent responses [Armstrong and Overton 1977; Lindner et al. 2001]. The underlying assumption of this approach is that late respondents are more similar to non-respondents than early respondents [Armstrong and Overton 1977]. A t-test comparison of the early and late respondents does not indicate any significant difference in the theoretical model's major constructs. Thus, we conclude that non-response bias is not an issue in this study.

4. Results

We used the partial least squares (PLS) method to evaluate the measurement and the structural model. PLS is a component-based structural equation modelling (SEM) method that is appropriate for prediction and theory development [Chin and Newsted 1999; Henseler et al. 2009]. In contrast, the covariance-based structural equation model (CBSEM) is mainly used for theory testing and confirmative analysis [Henseler et al. 2009]. Therefore, we adopted PLS rather than CBSEM to evaluate the model, since this study seeks to develop a theory that to predict. We used the SmartPLS 2.0 M3 [Ringle et al. 2005] software application for data analysis.

4.1 Assessment of the Measurement Model

4.1.1 Validating the Reflective Constructs

Before testing the theoretical model, we established the measurement model and assessed its adequacy. We modeled system quality as a second-order reflective construct containing three subconstructs: accessibility, timeliness, and flexibility. This specification and conceptualization of the system quality has been repeatedly employed and validated in prior studies [DeLone and McLean 2003; Petter et al. 2008; Petter et al. 2012; Sedera and Gable 2004]. Following Moshagen and Thielsch [2010], we modelled visual aesthetics as a second-order reflective construct and conceptualized it as containing four subconstructs: simplicity, diversity, colorfulness, and craftsmanship. We modeled all the remaining constructs as first-order reflective constructs. We evaluated the measurement model with internal consistency reliability, indicator reliability, convergent validity, and discriminant validity [Urbach and Ahlemann 2010].

First, we assessed the constructs' internal consistency reliability with Cronbach's alpha and composite reliability. These two indicators denote the extent to which items in one construct have the same range and meaning [Cronbach 1951]. As reported in Table 2, Cronbach's alpha and the composite reliability of all the first-order and second-order

constructs were greater than 0.88, which indicates high internal consistency [Nunnally and Bernstein 1994]. However, some of the constructs achieved an internal consistency value higher than 0.95, indicating risks of common method bias (CMB) [Straub et al. 2004]. We evaluate CMB in detail in the next section.

Table 2. Descriptive Statistics and Reliability Tests

Construct		Mean	Standard Deviation	**Cronbach's alpha**	**Composite reliability**	**AVE**
First order	BI	5.555	1.444	0.937	0.955	0.842
	PEOU	5.493	1.097	0.953	0.966	0.877
	PU	5.270	1.237	0.882	0.919	0.739
	SAT	5.238	1.227	0.926	0.947	0.818
	SQA	5.676	1.100	0.956	0.968	0.884
	SQF	4.824	1.318	0.943	0.963	0.897
	SQT	5.485	1.120	0.943	0.957	0.815
	VACF	5.134	1.052	0.817	0.916	0.845
	VACL	4.825	1.077	0.819	0.917	0.847
	VAD	4.686	1.162	0.883	0.928	0.811
	VAS	5.108	1.043	0.889	0.931	0.819
Second order	SQ	5.427	1.001	0.950	0.957	0.651
	VA	4.943	0.951	0.937	0.946	0.637

Notes: BI = behavior intention; PEOU = perceived ease of use; PU = perceived usefulness; SAT = user satisfaction; SQA = system accessibility; SQF = system flexibility; SQT = system timeliness; VACF = craftsmanship; VACL = colorfulness; VAD = diversity; VAS = simplicity; SQ = system quality; VA = visual aesthetic.

Second, to assess the constructs' indicator reliability and convergent validity, we examined the indicator loadings and the average variance extracted (AVE). All the indicator loadings were above the recommended level of 0.707 [Chin 1998], indicating that the latent variables explained at least 50% of the indicators' variances (cf. Appendix 1 for details). We therefore considered the indicators consistent with their constructs. Similarly, Table 2 shows that the AVE values of all the first-order and second-order constructs are well above the recommended value of 0.50, demonstrating the constructs' sufficient convergent validity.

Third, we assessed the constructs' discriminant validity by examining the cross-loadings of the indicators on other constructs [Chin 1998]. All the indicators loaded higher on their designated constructs than on any other construct, and all the constructs had the highest loadings on their indicators, suggesting that the constructs differ from one another (cf. Appendix 1 for details). In addition, we used the Fornell-Larcker criterion [1981] to assess discriminant validity. As reported in Table 3, the square roots of the AVE scores of all the constructs are higher than the correlation with any other constructs, indicating the constructs' satisfactory discriminant validity.

Table 3. Discriminant Validity Test

Correlation of first-order latent variables (square root of AVE on the diagonal)

	BI	PEOU	PU	SAT	SQA	SQF	SQT	VACF	VACL	VAD	VAS
BI	0.918										
PEOU	0.487	0.936									
PU	0.617	0.550	0.860								
SAT	0.663	0.678	0.737	0.905							
SQA	0.444	0.667	0.507	0.577	0.940						
SQF	0.247	0.475	0.361	0.432	0.518	0.947					
SQT	0.406	0.656	0.466	0.567	0.780	0.498	0.903				
VACF	0.370	0.655	0.424	0.550	0.516	0.431	0.524	0.919			
VACL	0.301	0.571	0.359	0.492	0.436	0.411	0.467	0.718	0.920		
VAD	0.317	0.585	0.408	0.534	0.485	0.633	0.526	0.656	0.702	0.901	
VAS	0.397	0.762	0.464	0.591	0.555	0.444	0.573	0.773	0.691	0.634	0.905

Correlation of second-order latent variables (square root of AVE on the diagonal)

	SQ	VA
SQ	0.807	
VA	0.665	0.798

4.1.2 Common Methods Variance

Since we only collected self-reported data and measured all the major constructs on a seven-point Likert scale, common method biases originating from sources such as the consistency motif [Podsakoff 1986] and from common scale formats [Tourangeau et al. 2000] could influence the model testing results' validity. We assessed the severity of the common method biases with three tests. First, we performed a Harman's single-factor test by including all the main constructs' indicators in a principal component analysis [Podsakoff 1986]. The result shows that six factors are extracted, of which none consider the majority of the covariance. Second, we examined the correlation matrix and the highest coefficient is 0.780, well below the critical level of 0.90 [Pavlou et al. 2007]. Third, we divided the sample into two subsamples according to whether or not the respondents provided very different responses (difference > 3) on the seven-point Likert scales for non-reversed items. We used the two data subsamples to assess the structural model separately and compared the assessment results. The idea is that the consistency motif [Podsakoff 1986] and common scale formats [Tourangeau et al. 2000] – two major sources of CMB in this study – are less likely to influence respondents who provide very different responses on the same type of seven-point Likert scale. The comparison shows that there is no significant difference in the path coefficients that the two subsamples calculated, indicating that the results from the two respondent sets may not significantly change the relationships between the constructs in the theoretical model. Thus, we suggest that CMB is not an issue in this study.

4.2 Assessment of the Structural Model

4.2.1 Direct Effects of Form and Function

Wixom and Todd's integrative theory indicates that system quality contributes significantly to user satisfaction and behavioral intention [DeLone and McLean 1992; McKinney et al. 2002; Wixom and Todd 2005], and we are interested in whether adding visual aesthetics as a predictor would further improve the prediction of user satisfaction. We therefore tested two structural models that excluded, or included, visual aesthetics, and compared the results. We used the PLS algorithm and bootstrapping analyses with 2,295 cases and 1,000 re-samples to test the models.

In the first step, we tested the model without including visual aesthetics. We found that the coefficient of the path between system quality and user satisfaction is highly significant ($t = 44.9$, $p < 0.001$). System quality alone explains 38.3% of the variances of user satisfaction, which indicates moderate explanatory power [Chin 1998]. Moderate explanatory power is acceptable for this model, since only one or two exogenous latent variables explain all the endogenous latent variables [Chin 1998]. Thus, the data support H1. Further, the data also support the paths between

user satisfaction, perceived usefulness, perceived ease of use, and behavioral intention, which Wixom and Todd [2005] suggested in their integrative theory. Since the data show consistent results as a previously verified theory, we are confident that the data are of good quality and can be used to test the extended model we suggest.

In the second step, we included visual aesthetics as a predictor and tested the model again. The user satisfaction's explained variance increased from 38.3% to 46.2%. The path between system quality and user satisfaction remained significant ($t = 14.37$, $p < 0.001$). Additionally, the path between visual aesthetics and user satisfaction was also significant ($t = 14.86$, $p < 0.001$). Evaluated with Cohen's f2 [Cohen 1988], the effect size of the path from visual aesthetics to user satisfaction is 0.150, indicating a medium effect on satisfaction [Chin 1998; Cohen 1988]. Thus, the data support H2. Overall, the result fits our expectation and suggests that visual aesthetics contributes significantly to user satisfaction, which extends Wixom and Todd's integrative theory. The PLS structural model results are presented in Figure 2.

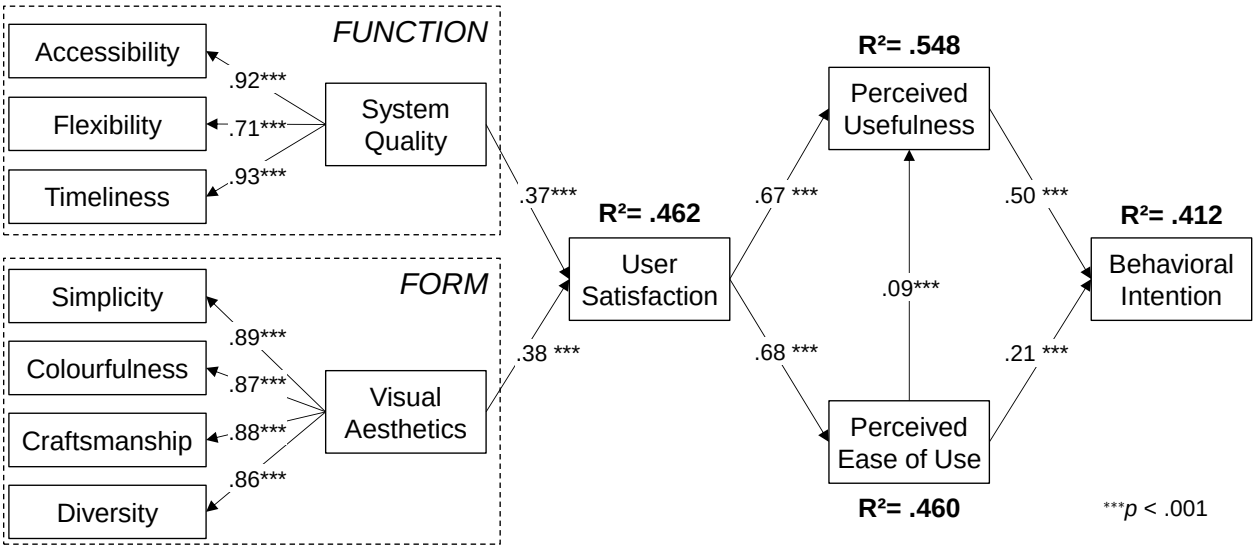

Figure 2: PLS Structural Model Results

4.2.2 Moderating Effects

To examine whether the relationships between the two design components and user satisfaction are contingent on certain contextual factors, we tested the moderating effects of age, gender, usage frequency, experience, device type (smartphone vs. tablet), and service delivery type (native app vs. mobile website). We measured age, usage frequency, and experience with metric indicators, while gender, device type, and service delivery type were dichotomous variables; we therefore adopted the product indicator approach [Henseler and Fassott 2010b; Sarstedt 2011] to test their moderating effects. This approach assumes that the moderator has a linear influence on the moderated direct relationship [Henseler and Fassott 2010a], which is a reasonable assumption for metric variables and dichotomous variables. We added a product term in the structural model, which we measured with the products between the indicators of the moderator variable and those of the various exogenous variable. We performed the PLS algorithm and bootstrapping analyses with 2,295 cases and 1,000 re-samples to test the moderating effects' strengths. The results show that age positively moderates the relationship between visual aesthetics and user satisfaction ($p < 0.05$), and that the usage frequency negatively moderates this relationship ($p < 0.001$). We detected no other moderating effects. This suggests that visual aesthetics affects user satisfaction with the system more strongly among older users than younger users, and more strongly among less intensive users than intensive users. Thus, the data support H4a, with age as a moderator, and H4c, with usage frequency as a moderator, while the other hypotheses on moderation effects were not supported by the data.

5. Discussion

First, our empirical results confirm the positive relationship between function and user satisfaction [McKinney et al. 2002; Petter et al. 2008; Seddon 1997]. Furthermore, the results show that, beyond the influence of function, form can further increase user satisfaction, which is also consistent with the single findings of previous studies [Cyr 2008; Lindgaard and Dudek 2003; Tractinsky et al. 2000; Zhang and von Dran 2000], suggesting that form has a positive impact on satisfaction. However, since these studies always examined a single design element, they were limited in

their explanatory contribution. Our study simultaneously investigates the impacts of form and function on a utilitarian MDS environment and finds that the two design components are equally important concerning their effects on satisfaction in this context. We found two interesting moderating effects concerning the six potential moderators. First, mobile banking user age positively moderates the relationship between form and user satisfaction. Accordingly, older users seem to be more sensitive to the form element than younger users. Thus, form is an important lever for mobile banking providers to satisfy older users. This interesting result is consistent with previous research in the field of consumer research and design [Eckmann and Wagner 1994]. Second, mobile banking service usage frequency negatively moderates the relationship between form and user satisfaction. Accordingly, form is more important for the satisfaction of less intensive users.

Besides the two interesting effects relating to form, neither age nor usage frequency moderates the relationship between function and user satisfaction. This means that the function element represents some kind of basic prerequisite for user satisfaction and is an important factor to satisfy all users, irrespective of their age and usage frequency. Our research extends the current body of knowledge by identifying age and usage frequency as two critical moderators that influence the relationship between form and user satisfaction in mobile data services.

Finally, no other potential moderator shows any significant impact on the relationship between form or function and satisfaction. This is especially interesting regarding the mobile device type (smartphone vs. tablet) and service delivery type (native app vs. mobile website), since users seem to not differentiate in their evaluation of the mobile banking service design. Users perceive form and function as equally important, no matter whether they are using a smartphone or a tablet, or whether they are using a native app or a mobile website to conduct mobile banking activities.

Finally, another interesting finding is that we could detect no significant differences between the different mobile banking providers concerning user evaluations of the form and function of their mobile banking applications. The results indicate that German mobile banking providers currently seem to meet customer expectations. Thus, when looking at the different current mobile banking services, we recognized that, from a form and function perspective, the different service offerings were similar. In other words, the single mobile banking services were rated as similar concerning form and function; that is, in appearance and performance. The relatively high maturity of the mobile banking applications is a possible explanation. In other words, the single mobile banking providers have had enough time to adapt their solutions to the respective best-in-class solution. Accordingly, possible form and function innovations are available to all providers of mobile banking applications, who can also utilize them.

6. Conclusion

Our work empirically investigates how form and function influence users' satisfaction with utilitarian MDS and their subsequent behavioral intention. Based on a large-scale survey study with mobile banking users in Germany, we find that both form and function have significant impacts on satisfaction with MBS. Higher age positively moderates the impact of form on satisfaction, while the usage frequency moderates it negatively. Overall, the results highlight that, in addition to function, which is taken for granted, form is a key predictor of user satisfaction in the context of mobile banking services.

We contribute to research by enriching the IS literature with an integrated view of utilitarian MDS design. Our study provides a clear conceptualization of the form and the function components, and rigorously validates the conceptualizations in a large-scale quantitative study. Based on our results, we suggest that, in terms of visual aesthetics, the design component of form should be a further important object-based belief to be considered in utilitarian MDS studies. Furthermore, the two interesting identified moderating effects of age and usage frequency on the relationship between form and user satisfaction advance the current body of knowledge about utilitarian MDS.

For practice, our study highlights that both form and function have a significant impact on user satisfaction. Thus, providers of utilitarian MDS should place equal emphasis on form and function in terms of investment priorities related to functional and visual aspects. Concerning the individual characteristics of mobile banking users, there are two primary insights for MBS design: First, function seems to be a hygiene precondition for user satisfaction that is unaffected by age and usage frequency. Second, form is of specific importance for older users with lower usage frequency. This suggests that form-related factors, such as simplicity and colorfulness, are important levers to satisfy this user population group. Further, we found that neither the device type (smartphone vs. tablet) nor the delivery approach type (native app vs. mobile website) of the mobile banking service seems to moderate the effects of form or function on satisfaction. Thus, it seems that no dedicated design is required for the different device types, and that a cheaper mobile website approach (e.g. based on HTML5) can be followed without negative impacts on satisfaction. This prevents additional costs resulting from development on multiple mobile platforms [Tiwana et al. 2010]. Finally, our results reveal that there are currently no statistical differences between the different mobile banking applications. Mobile banking providers need to think about more disruptive approaches that will allow them to go beyond the

current maturation phase in order to gain a competitive advantage. Creating symbolic value by incorporating special designs, fashions, and styles could be a possible solution [Candi and Saemundsson 2011].

Beside contributions, our research has limitations. First, our study investigated the design of MBS as a specific category of utilitarian MDS. Since MBS are utilitarian by nature, our findings could hold true for these MDS, especially those highly dependent on informational content. In contrast, our findings have limited implications for other MDS types, such as hedonic ones. These types are more centered around enjoyment, are less information-dependent, and proved different to utilitarian ones concerning user acceptance [van der Heijden 2004; Wakefield and Whitten 2006]. Future research should validate the theoretical model in the context of these other MDS types, such as gaming services or other entertainment-focused services, and should investigate a mandatory MDS usage scenario's possible influence, in contrast to that of voluntary usage [Chen et al. 2012]. Second, we could not control the sampling methods that the employed online research panel provider adopted. Another issue relates to the self-selection of the panelists, since their cooperation with the panel company is voluntary and based on incentives. Therefore, our sample may not perfectly represent the mobile banking user population in terms of individual characteristics. However, it must be noted that we reached a fairly representative sample of the German banking landscape concerning the distribution of mobile banking service providers. Third, we cannot completely rule out the potential existence of common method bias. However, in the survey, we also asked the respondents to report the most important and the most disrupting factors for their evaluation of mobile banking services in two voluntary open-ended questions. Of the 937 respondents who answered these questions, 282 deemed system quality as highly important, while 121 deemed visual aesthetics as very important for their evaluation of mobile banking services. These qualitative evidences are in accordance with the results of the structural model assessment, highlighting the importance of form and function for user satisfaction with mobile banking services.

Future research could improve the validity of our results by combining actual usage data with self-reported usage data, or by collecting longitudinal data instead of cross-sectional data. Another interesting matter for future research emerges from our study's national background, since our sample comprised only German mobile banking users. Future studies could investigate whether the influence of nationality as a design perception – especially concerning the evaluation of form and function – varies across countries due to distinct cultural values and prior experiences. Finally, some definitions suggest that meaning (emotional and symbolic value) is, besides form and function, an additional dimension of design [Bloch 2011; Van Rompay et al. 2009; Verganti 2008]. Meaning plays a major role in determining consumer responses and has the potential to dominate form and function [Crilly et al. 2004]. In contrast to form or function, meaning aims at customers' affective and sociocultural needs, rather than their utilitarian needs [Verganti 2008]. Future studies could extend our model by including this design dimension.

REFERENCES

Accenture. 2013. *Mobile Web Watch 2013: The New Persuaders*.

Aladwani, Adel M., and Prashant C. Palvia. 2002. "Developing and Validating an Instrument for Measuring User-Perceived Web Quality." *Information & Management* 39(6):467–76.

Al-Jabri, I., and Sohail, M.S. 2012. "Mobile Banking Adoption: Application of Innovation Diffusion Theory." *Journal of Electronic Commerce Research* 13(4):379-391.

Armstrong, J., and T. Overton. 1977. "Estimating Nonresponse Bias in Mail Surveys." *Journal of marketing research* 14(3):396–402.

Bagozzi, R. P. 2007. "The Legacy of the Technology Acceptance Model and a Proposal for a Paradigm Shift." *Journal of the Association for Information Systems* 8(4):244–54.

Benbasat, Izak, and Henri Barki. 2007. "Quo Vadis, TAM?" *Journal of the Association for Information Systems* 8(4):212–18.

Benbasat, Izak, and Robert W. Zmud. 2003. "The Identity Crisis within the Is Discipline: Defining and Communicating the Discipline's Core Properties." *MIS Quarterly* 27(2):183–94.

Bloch, Peter H. 1995. "Seeking the Ideal Form: Product Design and Consumer Response." *Journal of Marketing* 59(3):16–29.

Bloch, Peter H. 2011. "Product Design and Marketing: Reflections After Fifteen Years." *Journal of Product Innovation Management* 28(3):378–80.

Bloch, Peter H., Frédéric F. Brunel, and Todd J. Arnold. 2003. "Individual Differences in the Centrality of Visual Product Aesthetics: Concept and Measurement." *Journal of Consumer Research* 29(4):551–65.

Brislin, Richard W. 1986. "The Wording and Translation of Research Instruments." Pp. 137–64 in *Field methods in cross-cultural research.*, edited by Walter J Lonner and John W Berry. Thousand Oaks, CA US: Sage Publications, Inc.

Brown, Shona A., A. P. Massey, M. M. Montoya-Weiss, and J. R. Burkman. 2002. "Do I Really Have to? User Acceptance of Mandated Technology." *European Journal of Information Systems* 11(4):283–95.

Candi, Marina, and Rögnvaldur J. Saemundsson. 2011. "Exploring the Relationship Between Aesthetic Design as an Element of New Service Development and Performance." *Journal of Product Innovation Management* 28(4):536–57.

Chea, Sophea, and Margaret Meiling Luo. 2008. "Post-Adoption Behaviors of E-Service Customers: The Interplay of Cognition and Emotion." *International Journal of Electronic Commerce* 12(3):29–56.

Chen, Leida, Thomas O. Meservy, and Mark Gillenson. 2012. "Understanding Information Systems Continuance for Information-Oriented Mobile Applications." *Communications of AIS* 30:127–46.

Chin, Wynne W. 1998. "Commentary: Issues and Opinion on Structural Equation Modeling." *MIS quarterly* 22(1):vii–xvi.

Chin, Wynne W., and P. R. Newsted. 1999. "Structural Equation Modeling Analysis with Small Samples Using Partial Least Squares." Pp. 307–42 in *Statistical strategies for small sample research*, edited by Rick H. Hoyle. Thousand Oaks: Sage Publications.

Choi, Hun, Minkyung Lee, Kun Shin Im, and Jinwoo Kim. 2007. "Contribution to Quality of Life: A New Outcome Variable for Mobile Data Service." *Journal of the Association for Information Systems* 8(12):598–618.

Cohen, J. 1988. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Cortimiglia, Marcelo Nogueira, Antonio Ghezzi, and Filippo Renga. 2011. "Mobile Applications and Their Delivery Platforms." *IT Professional* 13(5):51–56.

Crilly, Nathan, James Moultrie, and P. J. Clarkson. 2004. "Seeing Things: Consumer Response to the Visual Domain in Product Design." *Design Studies* 25(6):547–77.

Cronbach, LJ. 1951. "Coefficient Alpha and the Internal Structure of Tests." *Psychometrika* 16(3):297–334.

Cyr, Dianne. 2008. "Modeling Web Site Design Across Cultures: Relationships to Trust, Satisfaction, and E-Loyalty." *Journal of Management Information Systems* 24(4):47–72.

Cyr, Dianne, Milena Head, and Alex Ivanov. 2006. "Design Aesthetics Leading to M-Loyalty in Mobile Commerce." *Information & Management* 43(8):950–63.

Davis, Fred D. 1989. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology." *MIS Quarterly* 13(3):319–40.

Davis, Fred D., and Viswanath Venkatesh. 1996. "A Critical Assessment of Potential Measurement Biases in the Technology Acceptance Model: Three Experiments." *International Journal of Human-Computer Studies* 45(1):19–45.

DeLone, W. H., and E. R. McLean. 1992. "Information Systems Success: The Quest for the Dependent Variable." *Information systems research* 3(1):60–95.

DeLone, William H., and Ephraim R. McLean. 2003. "The DeLone and McLean Model of Information Systems Success: A Ten-Year Update." *Journal of management information systems* 19(4):9–30.

DeLone, William H., and Ephraim R. McLean. 2004. "Measuring E-Commerce Success: Applying the DeLone & McLean Information Systems Success Model." *International Journal of Electronic Commerce* 9(1):31–47.

DeLong, M. R.. 1987. "The Way We Look", Ames, IA: Iowa State University Press.

Dillman, DA, JD Smyth, and LM Christian. 2008. "Internet, Mail, and Mixed-Mode Surveys: The Tailored Design Method."

Eckman, M. and Wagner, J. 1994. "Judging the Attractiveness of Product Design: the Effect of Visual Attributes and Consumer Characteristics", in Advances in Consumer Research, Volume 21, eds. Chris T. Allen and Deborah Roedder John, Provo, Association for Consumer Research, pages: 560-564.

Fornell, C., and DF Larcker. 1981. "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error." *Journal of marketing research* 18(1):39–50.

Hauser, John, Gerard J. Tellis, and Abbie Griffin. 2006. "Research on Innovation: A Review and Agenda for Marketing Science." *Marketing Science* 25(6):687–717.

Van der Heijden, Hans. 2003. "Factors Influencing the Usage of Websites: The Case of a Generic Portal in The Netherlands." *Information & Management* 40(6):541.

Van der Heijden, Hans. 2004. "User Acceptance of Hedonic Information Systems." *MIS Quarterly* 28(4):695–704.

Henseler, J., and Georg Fassott. 2010a. "Handbook of Partial Least Squares: Concepts, Methods and Applications." Pp. 713–35 in *Handbook of partial least squares*, edited by Vincenzo Esposito Vinzi, Wynne W. Chin, Jörg Henseler, and Huiwen Wang. Berlin, Heidelberg, Heidelberg: Springer.

Henseler, J., and Georg Fassott. 2010b. “Testing Moderating Effects in PLS Path Models: An Illustration of Available Procedures.” Pp. 713–35 in *Handbook of partial least squares*, edited by Vincenzo Esposito Vinzi, Wynne W. Chin, Jörg Henseler, and Huiwen Wang. Berlin, Heidelberg: Springer Berlin Heidelberg.

Henseler, Jörg, Christian M. Ringle, and Rudolf R. Sinkovics. 2009. “The Use of Partial Least Squares Path Modeling in International Marketing.” in *Advances in International Marketing*, vol. 20, edited by Rudolf R. Sinkovics and Pervez N. Ghauri. Bingley: Emerald Group Publishing.

Hertenstein, Julie H., Marjorie B. Platt, and Robert W. Veryzer. 2005. “The Impact of Industrial Design Effectiveness on Corporate Financial Performance.” *Journal of Product Innovation Management* 22(1):3–21.

Holbrook, M. B. and Schindler, R. M. 1989. "Some Exploratory Findings on the Development of Musical Tastes." *Journal of Consumer Research*, 16 (June):119-124.

Hollins, Bill, and Stuart Pugh. 1990. *Successful Product Design: What to Do and When*. London: Butterworths.

Hong, Se-Joon, and Kar Yan Tam. 2006. “Understanding the Adoption of Multipurpose Information Appliances: The Case of Mobile Data Services.” *Information Systems Research* 17(2):162–79.

Hoyer, Wayne, and Nicola Stokburger-Sauer. 2012. “The Role of Aesthetic Taste in Consumer Behavior.” *Journal of the Academy of Marketing Science* 40(1):167–80.

Husson, Thomas, and Reineke Reitsma. 2013. “The European Tablet Landscape.”

Huynh, Susan, and Jeff Wray. 2012. “Forrester Research World Mobile Adoption Forecast, 2011 To 2016 (Global).”

Ketkar, S.P., Shankar, R., and Banwet, D.K. 2012. "Structural Modeling and Mapping of M-Banking Influencers in India." *Journal of Electronic Commerce Research* 13(1):70-87.

Kim, Byoungsoo, and Ingoo Han. 2011. “The Role of Utilitarian and Hedonic Values and Their Antecedents in a Mobile Data Service Environment.” *Expert Systems with Applications* 38(3):2311–18.

Kim, Hoyoung, Inseong Lee, and Jinwoo Kim. 2008. “Maintaining Continuers vs. Converting Discontinuers: Relative Importance of Post-Adoption Factors for Mobile Data Services.” *International Journal of Mobile Communications* 6(1):108–32.

King, WR, and J. He. 2005. “External Validity in IS Survey Research.” *Communications of the Association for Information Systems* 16:880–94.

Kotler, Philip, and G. Alexander Rath. 1984. “Design: A Powerful but Neglected Strategic Tool.” *The Journal of Business Strategy* 5(2):16.

Lavie, Talia, and Noam Tractinsky. 2004. “Assessing Dimensions of Perceived Visual Aesthetics of Web Sites.” *International Journal of Human-Computer Studies* 60(3):269–98.

Lawson, B., and K. Dorst. 2009. *Design Expertise*. New York, NY: Architectural Press.

Lee, S., B. Shin, and HG Lee. 2009. “Understanding Post-Adoption Usage of Mobile Data Services: The Role of Supplier-Side Variables.” *Journal of the Association for Information Systems* 10(12):860–88.

Lee, Young Eun, and Izak Benbasat. 2003. “Interface Design for Mobile Commerce.” *Communications of the ACM* 46(12):48–52.

Lee, Younghwa, Kenneth A. Kozar, and Kai R. T. Larsen. 2003. “The Technology Acceptance Model: Past, Present, and the Future.” *Communications of AIS* 12:752–80.

Li, Yung-Ming, and Yung-Shao Yeh. 2010. “Increasing Trust in Mobile Commerce through Design Aesthetics.” *Computers in Human Behavior* 26(4):673–84.

Lim, Heejin, Richard Widdows, and Jungkun Park. 2006. “M-Loyalty: Winning Strategies for Mobile Carriers.” *Journal of Consumer Marketing* 23(4/5):208–18.

Lin, Hsin-Hui, and Yi-Shun Wang. 2006. “An Examination of the Determinants of Customer Loyalty in Mobile Commerce Contexts.” *Information & Management* 43(3):271–82.

Lindgaard, Gitte, and Cathy Dudek. 2003. “What Is This Evasive Beast We Call User Satisfaction?” *Interacting with Computers* 15(3):429–52.

Lindner, James R., Tim H. Murphy, and Gary E. Briers. 2001. “Handling Nonresponse In Social Science Research.” *Journal of Agricultural Education* 42(4):43–53.

Loiacono, Eleanor T., Richard T. Watson, and Dale L. Goodhue. 2007. “WebQual: An Instrument for Consumer Evaluation of Web Sites.” *International Journal of Electronic Commerce* 11(3):51–87.

López-Nicolás, Carolina, Francisco J. Molina-Castillo, and Harry Bouwman. 2008. “An Assessment of Advanced Mobile Services Acceptance: Contributions from TAM and Diffusion Theory Models.” *Information & Management* 45(6):359–64.

Luchs, Michael, and K. Scott Swan. 2011. “Perspective: The Emergence of Product Design as a Field of Marketing Inquiry.” *Journal of Product Innovation Management* 28(3):327–45.

Maedche, Alexander, Achim Botzenhardt, and Ludwig Neer. 2012. “Software for People: A Paradigm Change in the Software Industry.” Pp. 1–8 in *Software for People - Fundamentals, Trends and Best Practices*, edited by Alexander Maedche, Achim Botzenhardt, and Ludwig Neer. Berlin ; Heidelberg: Springer.

Mahmood, Mo Adam, Burn, Janice M., Gemoets, Leopoldo A., and Jacquez, Carmen. 2000. "Variables affecting information technology end-user satisfaction: a meta-analysis of the empirical literature", *International Journal of Human-Computer Studies*, 52(4):751-771.

McKinney, Vicki, Kanghyun Yoon, and Fatemeh Zahedi. 2002. “The Measurement of Web-Customer Satisfaction: An Expectation and Disconfirmation Approach.” *Information Systems Research* 13(3):296–315.

Moshagen, Morten, and Meinald T. Thielsch. 2010. “Facets of Visual Aesthetics.” *International Journal of Human-Computer Studies* 68(10):689–709.

Moshagen, Morten, and Meinald T. Thielsch. 2012. “A Short Version of the Visual Aesthetics of Websites Inventory.” *Behaviour & Information Technology* (February 2013):1–7.

Nah, Fiona Fui-Hoon, Keng Siau, and Hong Sheng. 2005. “The Value of Mobile Applications.” *Communications of the ACM* 48(2):85–90.

Nunnally, Jum C., and Ira H. Bernstein. 1994. *Psychometric Theory*. 3rd ed. New York: McGraw.

Oakley, Mark. 1990. *Design Management: A Handbook of Issues and Methods*. Blackwell Reference.

Pavlou, PA, H. Liang, and Y. Xue. 2007. “Understanding and Mitigating Uncertainty in Online Exchange Relationships: A Principal-Agent Perspective.” *MIS quarterly* 31(1):105–36.

Petter, Stacie, William Delone, and Ephraim Mclean. 2008. “Measuring Information Systems Success: Models, Dimensions, Measures, and Interrelationships.” *European Journal of Information Systems* 17(3):236–63.

Petter, Stacie, William DeLone, and Ephraim R. McLean. 2012. “The Past, Present, and Future of ‘IS Success’.” *Journal of the Association for Information Systems* 13(5):341–62.

Podsakoff, P. M. 1986. “Self-Reports in Organizational Research: Problems and Prospects.” *Journal of Management* 12(4):531–44.

Rindova, Violina P., and Antoaneta P. Petkova. 2007. “When Is a New Thing a Good Thing? Technological Change, Product Form Design, and Perceptions of Value for Product Innovations.” *Organization Science* 18(2):217–32.

Ringle, Christian Marc, Sven Wende, and Alexander Will. 2005. “SmartPLS.” *www.smartpls.de*.

Van Rompay, Thomas J. L., Ad T. H. Pruyn, and Peter Tieke. 2009. “Symbolic Meaning Integration in Design and Its Influence on Product and Brand Evaluation.” *International Journal of Design* 3(2):19–26.

Sarstedt, Marko. 2011. “Multigroup Analysis in Partial Least Squares (PLS) Path Modeling: Alternative Methods and Empirical Results.” *Advances in International Marketing* 22(2011):195–218.

Seddon, P. B. 1997. “A Respecification and Extension of the DeLone and McLean Model of IS Success.” *Information Systems Research* 8(3):240–53.

Sedera, Darshana, and GG Gable. 2004. “A Factor and Structural Equation Analysis of the Enterprise Systems Success Measurement Model.” Pp. 449–64 in *Proceedings of the 25th International Conference on Information Systems*, edited by R. Agarwal, L. Kirsch, and J. I. DeGross. Atlanta: AIS.

Shankar, V., Smith, A.K. and Rangaswamy, A. 2003. "Customer satisfaction and loyalty in online and offline environments", *International Journal of Research in Marketing*, 20(2):153-175.

Spreng, Richard A., Scoff B. Scott B. MacKenzie, and Richard W. Olshavsky. 1996. “A Reexamination of the Determinants of Consumer Satisfaction.” *Journal of Marketing* 60(3):15.

Straub, Detmar, MC Boudreau, and David Gefen. 2004. “Validation Guidelines for IS Positivist Research.” *Communications of the AIS* 13:380–427.

Thong, James Y. L., Se-Joon Hong, and Kar Yan Tam. 2006. “The Effects of Post-Adoption Beliefs on the Expectation-Confirmation Model for Information Technology Continuance.” *International Journal of Human-Computer Studies* 64(9):799–810.

Tiwana, Amrit, Benn Konsynski, and Ashley A. Bush. 2010. “Platform Evolution: Coevolution of Platform Architecture, Governance, and Environmental Dynamics.” *Information Systems Research* 21(4):675–87.

Tourangeau, R., Lance J. Rips, and Kenneth Rasinski. 2000. *The Psychology of Survey Response*. Cambridge, UK: Cambridge University Press.

Townsend, Janell D., Mitzi M. Montoya, and Roger J. Calantone. 2011. “Form and Function: A Matter of Perspective.” *Journal of Product Innovation Management* 28(3):374–77.

Tractinsky, N., A. S. Katz, and D. Ikar. 2000. “What Is Beautiful Is Usable.” *Interacting with Computers* 13(2):127–45.

Tractinsky, Noam. 2004. “Toward the Study of Aesthetics in Information Technology.” Pp. 771–80 in *Proceedings of the 25th International Conference on Information Systems*. Atlanta: AIS.

Tractinsky, Noam. 2006. “Aesthetics in Information Technology: Motivation and Future Research Directions.” Pp. 330 – 347 in *Human-Computer Interaction and Management Information Systems: Applications*, edited by Dennis Galletta and Ping Zhang. Armonk, NY: M.E. Sharpe.

Ulrich, Karl T., and Steven D. Eppinger. 2012. *Product Design and Development*. New York, NY: McGraw-Hill.

Urbach, Nils, and Frederik Ahlemann. 2010. “Structural Equation Modeling in Information Systems Research Using Partial Least Squares.” *Journal of Information Technology Theory and Application* 11(2):5.

Urban, Glen L., and John R. Hauser. 1993. *Design and Marketing of New Products*. Englewood Cliffs, N.J.: Prentice Hall.

Venkatesh, V., and H. Bala. 2008. “Technology Acceptance Model 3 and a Research Agenda on Interventions.” *Decision Sciences* 39(2):273–315.

Venkatesh, V., and F. D. Davis. 2000. “A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies.” *Management science* 46(2):186–204.

Venkatesh, Viswanath. 1999. “Creation of Favorable User Perceptions: Exploring the Role of Intrinsic Motivation.” *MIS Quarterly* 23(2):239–60.

Venkatesh, Viswanath, Michael G. Morris, Gordon B. Davis, and Fred D. Davis. 2003. “User Acceptance of Information Technology: Toward a Unified View.” *MIS quarterly* 27(3):425–78.

Verganti, Roberto. 2008. “Design, Meanings, and Radical Innovation: A Metamodel and a Research Agenda.” *Journal of Product Innovation Management* 25(5):436–56.

Veryzer, Robert W. 1993. “Aesthetic Response and the Influence of Design Principles on Product Preferences.” *Advances in Consumer Research* 20(1):224–28.

Wakefield, Robin L., and Dwayne Whitten. 2006. “Mobile Computing: A User Study on Hedonic/utilitarian Mobile Device Usage.” *European Journal of Information Systems* 15(3):292–300.

Wixom, B. H., and P. A. Todd. 2005. “A Theoretical Integration of User Satisfaction and Technology Acceptance.” *Information Systems Research* 16(1):85–102.

Wright, Kevin B. 2006. “Researching Internet-Based Populations: Advantages and Disadvantages of Online Survey Research, Online Questionnaire Authoring Software Packages, and Web Survey Services.” *Journal of Computer-Mediated Communication* 10(3):00–00.

Xu, Jingjun (David), Izak Benbasat, and Ronald T. Cenfetelli. 2013. “Integrating Service Quality with System and Information Quality: An Empirical Test in the E-Service Context.” *MIS Quarterly* 37(3):777–A9.

Yu, Chian-Son. 2012. "Factors Affecting Individuals to Adopt Mobile Banking: Empirical Evnidence from the UTAUT Model." *Journal of Electronic Commerce Research* 13(2):104-121.

Zhang, Ping, and Gisela M. von Dran. 2000. “Satisfiers and Dissatisfiers: A Two-Factor Model for Website Design and Evaluation.” *Journal of the American Society for Information Science* 51(14):1253–68.

Zhongyun Zhou, Xiao-Ling Jin, Yulin Fang, 2014. “Moderating role of gender in the relationships between perceived benefits and satisfaction in social virtual world continuance”, *Decision Support Systems*, 65:69-79.

Appendix 1. Tests of Convergence Validity (n = 2,295)

	BI	PEOU	PU	SAT	SQA	SQF	SQT	VACF	VACL	VAD	VAS
BI1	0.878	0.515	0.636	0.677	0.465	0.244	0.436	0.382	0.306	0.313	0.423
BI2	0.941	0.432	0.551	0.588	0.402	0.226	0.354	0.325	0.258	0.288	0.346
BI3	0.930	0.402	0.522	0.571	0.364	0.215	0.337	0.307	0.260	0.274	0.326
BI4	0.921	0.421	0.536	0.579	0.380	0.214	0.346	0.333	0.272	0.282	0.347
PEOU1	0.441	0.925	0.498	0.612	0.605	0.438	0.595	0.626	0.550	0.540	0.725
PEOU2	0.455	0.953	0.512	0.636	0.622	0.440	0.609	0.618	0.524	0.538	0.719
PEOU3	0.466	0.936	0.535	0.660	0.635	0.485	0.627	0.618	0.550	0.591	0.716
PEOU4	0.463	0.932	0.515	0.632	0.635	0.417	0.627	0.593	0.516	0.522	0.695
PU1	0.621	0.568	0.863	0.700	0.528	0.276	0.495	0.414	0.336	0.342	0.469
PU2	0.524	0.475	0.915	0.640	0.438	0.343	0.405	0.375	0.314	0.372	0.400
PU3	0.404	0.306	0.764	0.496	0.294	0.273	0.274	0.272	0.256	0.316	0.278
PU4	0.541	0.500	0.890	0.669	0.447	0.351	0.393	0.377	0.316	0.371	0.418
SAT1	0.570	0.577	0.669	0.901	0.504	0.379	0.501	0.468	0.425	0.471	0.504
SAT2	0.642	0.659	0.693	0.934	0.560	0.389	0.544	0.526	0.472	0.492	0.561
SAT3	0.538	0.586	0.634	0.899	0.474	0.452	0.479	0.501	0.476	0.551	0.538
SAT4	0.646	0.629	0.669	0.883	0.546	0.345	0.524	0.495	0.408	0.421	0.532
SQA1	0.423	0.631	0.481	0.554	0.926	0.470	0.744	0.499	0.409	0.445	0.525
SQA2	0.423	0.626	0.478	0.535	0.953	0.485	0.733	0.479	0.399	0.447	0.510
SQA3	0.409	0.615	0.468	0.528	0.954	0.475	0.724	0.475	0.401	0.439	0.516
SQA4	0.414	0.637	0.482	0.552	0.928	0.517	0.734	0.486	0.429	0.490	0.535
SQF1	0.250	0.469	0.360	0.423	0.522	0.944	0.497	0.413	0.390	0.588	0.425
SQF2	0.212	0.438	0.321	0.396	0.468	0.959	0.452	0.385	0.370	0.592	0.399
SQF3	0.237	0.442	0.345	0.408	0.480	0.939	0.465	0.426	0.407	0.618	0.438
SQT1	0.374	0.597	0.434	0.522	0.697	0.460	0.903	0.473	0.431	0.489	0.522
SQT2	0.354	0.591	0.407	0.506	0.687	0.474	0.906	0.464	0.436	0.512	0.518
SQT3	0.394	0.634	0.448	0.546	0.730	0.485	0.925	0.489	0.440	0.510	0.538
SQT4	0.352	0.566	0.403	0.479	0.680	0.401	0.892	0.460	0.391	0.413	0.494
SQT5	0.359	0.573	0.411	0.504	0.729	0.426	0.889	0.480	0.411	0.446	0.515
VACF1	0.346	0.607	0.379	0.492	0.477	0.399	0.475	0.921	0.679	0.623	0.704
VACF2	0.334	0.598	0.402	0.520	0.472	0.394	0.489	0.918	0.641	0.584	0.717
VACL1	0.288	0.538	0.337	0.463	0.421	0.396	0.455	0.667	0.923	0.685	0.638
VACL2	0.265	0.513	0.322	0.443	0.379	0.359	0.404	0.655	0.917	0.606	0.634
VAD1	0.314	0.572	0.417	0.515	0.516	0.668	0.550	0.573	0.556	0.845	0.574
VAD2	0.256	0.489	0.337	0.454	0.377	0.525	0.418	0.581	0.656	0.928	0.552
VAD3	0.289	0.523	0.353	0.478	0.422	0.524	0.457	0.619	0.681	0.927	0.587
VAS1	0.373	0.674	0.420	0.518	0.515	0.394	0.527	0.685	0.606	0.550	0.901
VAS2	0.367	0.711	0.442	0.556	0.517	0.427	0.540	0.707	0.627	0.588	0.918
VAS3	0.339	0.681	0.398	0.528	0.474	0.385	0.489	0.705	0.644	0.582	0.895

Appendix 2. List of Model Constructs and Items

Behavioral intention (BI)

I intend to use this mobile banking application in the future.

I expect to use this mobile banking application in the future.

I plan to use this mobile banking application in the future.

I predict that I will use this mobile banking application in the future.

Satisfaction (SAT)

I am very happy with this mobile banking application.

I am very pleased with this mobile banking application.

I am delighted with this mobile banking application.

Overall, I am very satisfied with this mobile banking application.

Question items on system quality

Timeliness (SQT)

This mobile banking application is responsive to my requests.

This mobile banking application swiftly loads all the text and graphics.

This mobile banking application provides information in a timely way.

Accessibility (SQA)

This mobile banking application allows information to be readily accessible to me.

This mobile banking application makes information very accessible.

This mobile banking application makes information easy to access.

Flexibility (SQF)

This mobile banking application can be adapted to meet a variety of needs.

This mobile banking application can flexibly adjust to new demands or conditions.

This mobile banking application is versatile in addressing needs as they arise.

Perceived usefulness (PU)

This mobile banking application is useful in my daily life.

Using this mobile banking application helps me to accomplish things more quickly.

Using this mobile banking application increases my productivity.

Using this mobile banking application makes it easier to do banking business.

Perceived ease of use (PEOU)

This mobile banking application makes for easy orientation.

This mobile banking application is easy to operate.

It is easy to handle this mobile banking application.

This mobile banking application is easy to use.

Visual aesthetics (VA)

Simplicity (VAS)

The layout is easy to grasp.

Everything comes together in this application.

The layout appears well structured.

Diversity (VAD)

The layout is pleasantly varied.

The layout is inventive.

The layout appears dynamic.

Colorfulness (VACL)

The color composition is attractive.

The colors are appealing.

Craftsmanship (VACF)

The layout appears professionally designed.

The application is designed with care.

Appendix 3. List of Additional Items

Usage frequency

Never

Once a month

Several times per month

Weekly

Mobile device type

Smartphone (e.g. Apple iPhone, Samsung Galaxy, ...)

Tablet (e.g. Apple iPad, Samsung Galaxy Tab, Amazon Kindle Fire, ...)

Application type

Native app

Mobile website

Type of internet connection (concerning the last mobile banking transaction)

Mobile network of my mobile service provider (e.g. 3G, 4G/LTE, ...)

Public Wi-Fi

Non-public Wi-Fi

Other internet connection

Mobile banking experience

Up to 1 month

Up to 6 month

Up to 1 year

Several years

Provider

Third-party provider (no bank)

Sparkasse

Volksbank/Raiffeisenbank

Postbank

Deutsche Bank

Commerzbank (Dresdner Bank)

Sparda-Bank

Targobank

HypoVereinsbank (UniCredit)

ING-DiBa

Noris Bank

DKB (Direktbank)

Comdirect Bank

PSD Bank

DAB Direkt Anlage Bank

Cortal Consors

SEB

Other bank (including/providing branches)

Online/Direct bank (without branches)

Age

Gender

Education

Qualitative feedback part

Most disturbing issue about the mobile banking application

Missing feature within the mobile banking application