Determinants of the Willingness to Use Mobile Location-Based Services

An Empirical Analysis of Residential Mobile Phone Customers

Mobile network operators regard mobile location based services as a services category promising considerable business volume. However, up to now, the expectations were not met in full. The questions arise, what the reasons for demand restraint are, and how it can be reduced. The paper addresses these questions empirically by evaluating a survey of 217 private mobile phone customers in Germany.

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1 Study Background and Purpose

Context-aware or *location-based services* (*LBS*) are a mobile services category to which many attribute substantial revenue growth prospects. LBS use the current geospatial position of a mobile device in order to provide location-specific information, transaction opportunities, and communication options (Vrcek et al. 2009). In addition, by utilizing context data (e.g., weather) and static (e.g., gender) as well as dynamic personal characteristics (e.g., health) which go beyond the spatial device position, LBS can be tailored to a broad variety of customer needs and use situations (Bauer et al. 2008, pp. 207–208).

From a customer perspective more sophisticated LBS offering features exceeding basic navigation functionalities may be considered as innovative services. Consequently, mobile network operators (MNO) face the question which customer- and LBS-specific characteristics significantly affect the initial willingness to use innovative LBS types among customers in general and among "early adopters" (Rogers 2003, p. 281) in particular. The "early adopters" segment includes customers who tend to use LBS offers shortly after market launch. Respective findings may spark LBS-design and -marketing geared to customer requirements in the pioneer segment. Since later adopters are inclined to follow "early adopters" (Rogers 2003), LBS diffusion in subsequent target groups may be accelerated by successful marketing measures aiming at pioneer users.

To date, about 20 empirical studies on determinants of LBS adoption have already been published (Gerpott 2010, pp. 8–12). However, they are characterized by several deficiencies. First, "independent" variables (e.g., perceived LBS usefulness) and "dependent" criteria (e.g., attitude towards LBS) are frequently captured through almost tautological questionnaire items (Fang et al. 2006; Lee et al. 2009). Second, there is a dearth of studies that incorporate a broader range of determinants and mediated causal chains. Third, previous samples mostly consist of students (Sheng et al. 2008; Tsai et al. 2009). Thus, it remains unclear whether past results are valid for "early adopters" of LBS, who are indeed often male, more educated, and younger than the average population (Oh et al. 2008), but at the same time are not preponderantly students. Fourth, there are just two studies (Bauer et al. 2008; Gerpott 2010) focusing on customers of German MNO. Against this background, the purpose of the present study is to empirically explore multi-step effect chains among a broader range of potential LBS adoption determinants in a sample of residential MNO customers in Germany which is *not* dominated by students.

Based on the initiator of a service encounter LBS are frequently classified into push- and pull-oriented variants. *Pull* LBS are demanded by the user on a case-by-case basis, whereas *push*-oriented services require an explicit opt-in agreement of the users to automatically deliver the desired content in line with stated user preferences (e.g., mobile advertisement, current location). Our study focuses on *pull* LBS as there are indications that the willingness to use this service category is significantly stronger than for *push* LBS (Kölmel and Wirsing 2002; Fritsch and Muntermann 2005; Spiekermann 2008; Vrcek et al. 2009).

2 Development of Hypotheses

In order to identify user-related determinants of the adoption of innovative

LBS, we draw on the "Task-Individual-Technology-Fit" (TITF) framework as suggested by Goodhue and Thomson (1995). According to these authors, the willingness to use an innovative technical service is primarily influenced by two factors: (1) Degree of congruence between the innovation's functional features and task requirements, for which the innovation is deployed, and (2) degree of congruence between the system's requirements on user skills and the actual user capabilities (Dishaw and Strong 1999, pp. 11–12; Sheng et al. 2008, pp. 365–366).

With regard to the "Individual-Technology-Fit" for innovative mobile data services such as LBS, two indicators have been repeatedly used in earlier work: (1) self-ratings of one's skills to practically operate new services, and (2) extent of recent use of other mobile (data) services, which are technically related to an incrementally innovative service category. Previous studies (Tsai et al. 2009) found significant associations between these two indicators and various adoption criteria. Accordingly, we suggest the first hypothesis (H):

H1: The frequency of use of mobile data services in the recent past has a positive effect on willingness to use LBS.

The second key element of the TITF-framework – the degree of technical system support of a user in accomplishing personal or job-related tasks – has been addressed only sporadically in LBS studies (Yuan et al. 2010). As LBS are particularly helpful in case of unexpected information needs, it may be concluded from extant work that the willingness to use LBS and the demand for currently available mobile data services both increase as a person is more frequently "on the move". Therefore, we propose:

H2: Perceived frequency of spontaneous location-based information needs while "on the move" has a positive influence on willingness to use LBS.

H3: Perceived frequency of spontaneous location-based information needs while "on the move" has a positive effect on the current usage intensity of mobile data services.

The TITF-framework neglects that customers may seek advice from persons close to them (family members, colleagues, etc.) and may take note of relevant media reports before deciding to adopt innovative LBS offers. Therefore, many studies include a "social influence" (Rao and Troshani 2007, p. 67) or "social norm" (Dickinger et al. 2008, p. 7) construct. It focuses on the evaluation of new services by a person's close social contacts. According to Bauer et al. (2008) and Tsai et al. (2009), positive assessments of LBS by an individual's social peers coincide with a higher willingness to adopt LBS. Therefore, we suggest:

H4: Perceived positive evaluation of LBS usage by the social environment of a mobile network customer (MNC) positively effects the willingness to use LBS.

Furthermore, potential adoption impediments discussed intensively in the literature include risks that could be linked to the use of LBS in particular or mobile data services in general (Fritsch and Muntermann 2005; Zhou et al. 2010). The notion of risks includes a broad range of customer opinions regarding unexpected financial losses or other disadvantages coming along with the usage of particular mobile data services. One risk category results from the fact that residential MNC pay consumed mobile data services on their own account. Invoicing amounts caused by the use of mobile data services can be perceived as massive and hard to predict. This risk of excessive invoicing amounts is especially immanent if LBS tariffs vary depending on data transmission volumes or length of use as average customers are unlikely to be able to accurately forecast the values of such variables. Hence, unreasonable expectations may lead to invoice amounts which are perceived as unexpectedly high or even shocking (Gerpott 2007). Results of Bauer et al. (2008) and Kofod-Petersen et al. (2010) indicate that perceived risks of excessive invoicing amounts have a significantly negative effect on the willingness to use LBS. Put differently, we posit:

H5: The extent of perceived LBS specific risk of excessive invoicing amounts has a negative effect on the willingness to use LBS.

The extent of the perceived risk of excessive invoicing amounts caused by the usage of LBS is in turn reduced by the extent to which LBS are evaluated positively by the social environment of an MNC (Lu et al. 2003; Teo and Pok 2003). Since billing of LBS is in the hands of MNO it is evident that the stronger the customer's trust in one's own MNO the less is the perceived risk of excessive invoicing amounts (Gefen et al. 2003). Therefore, our hypotheses are:

H6: The extent to which usage of LBS is endorsed by the social environment of an MNC has a negative effect on the extent of the perceived risk of excessive invoicing amounts.

H7: The trust that an MNC puts on his/her own MNO is negatively related to the level of the perceived risk of unexpected excessive invoicing amounts caused by LBS usage.

Another risk category that is intensely discussed in the context of LBS deals with concerns of customers that LBS providers may collect more personal information than technologically required, generate defective personal data and/or misuse personal data for other purposes than LBS delivery or that third parties gain unauthorized data access (Smith et al. 1996). Past empirical LBS research overwhelmingly concludes that high perceived data privacy risks form an important LBS usage barrier (Junglas and Spitzmüller 2006; Sheng et al. 2008; Lee et al. 2009; Tsai et al. 2009; Kofod-Petersen et al. 2010). Thus, we test:

H8: The level of perceived LBS specific data privacy risks has a negative impact on the willingness to use LBS.

Potential LBS users often lack personal use experience as these innovative mobile data services are still in the early market launch phase. Therefore, they tend to pay much attention to opinions of third persons in developing their own opinions concerning LBS data privacy risks (Chen et al. 2008). Consequently, the evaluation of LBS data privacy risks is influenced by the extent to which LBS are endorsed by the close social contacts of an MNC. This reasoning suggests:

H9: The extent to which the social environment of an MNC endorses the use of LBS has a negative effect on perceived LBS data privacy risks.

Personal location data that is generated in the course of the "production" of LBS is under control of the respective MNO. Therefore, it can be argued to incorporate an MNC's trust in the technical and legal skills of one's own MNO as an additional factor which may influence perceived LBS data privacy risks (Junglas and Spitzmüller 2006; Chen et al. 2008; Kofod-Petersen et al. 2010). Therefore, we hypothesize:

H10: The trust in one's own MNO is negatively related to perceived LBS data privacy risks.

Finally, perceived risk of excessive invoicing amounts and perceived LBS data privacy risks can be distinguished conceptionally. Empirically, however, a reciprocal cause-effect relation between these

two risk dimensions is likely. Additionally, since cost considerations play a pivotal role in choosing an MNO from an MNC's viewpoint (Schade et al. 2009), we posit a stronger effect of perceived risk of excessive invoicing amounts on perceived LBS data privacy risks than vice versa:

H11: The extent of perceived LBS specific risk of excessive invoicing amounts has a positive impact on perceived LBS data privacy risks.

3 Research Methods

3.1 Sample and Analytical Procedure

Data were collected in Spring 2008 by means of a web-based survey open to all German-speaking residential customers of MNO. Data gathering efforts were supported by a grant from the *Deutsche Forschungsgemeinschaft* and by ideational help obtained from one German MNO. The main-survey was based on a standardized questionnaire with predominantly closed, predefined answer options. A link to the survey tool was hosted on several websites (e.g., customer portal of MNO, online-communities) to motivate individuals to fill in our questionnaire. As a result, 989 individuals worked through the questionnaire. 728 (= 73.6%) persons provided responses to the items relevant to the present paper. We excluded those 511 respondents from further analysis who selected the answer option "do not know" for at least one item used to capture this study's constructs. This approach is based on the rationale that LBS are relatively new mobile data services and therefore are likely to go along with knowledge and/or opinion gaps for some participants. Consequently, not all respondents may find themselves in a position to answer every item substantially. Therefore, it is advantageous to offer an answer category "do not know" to study participants such as ours. Due to the ambiguous meaning of this option we exclude persons from further statistical analysis who selected this answer category (Andrews 1984). As a result the sample analyzed in the remainder of this work consists of 217 MNC.[1]

79.9% of the respondents were male, 40.2% were younger than 26 and 5.9% had a university degree. Of the participants, 84.3% were postpaid customers of an MNO. 70% had already used mobile data services beyond SMS within the past 12 months. Compared to the total population in Germany, women, older and less educated people are underrepresented in our sample. But in contrast to samples of previous studies on LBS adoption (Junglas and Spitzmüller 2006; Sheng et al. 2008; Tsai et al. 2009) primarily involving students, our sample comprises a considerably broader distribution for the aforementioned socio-demographic variables. Therefore, this study's data may be seen as suited to test the research hypotheses at least in the "early adopter" segment of LBS if the findings are interpreted with caution. Furthermore, it is no indispensible methodological precondition that our data provides an unbiased reproduction of single variable distributions in a population because the key purpose of our work is to shed light on relations between constructs. The validity of results for such a research approach depends on the quality of construct measurements and the methods used to detect variable associations (East and Uncles 2008).

The hypotheses involve latent constructs, each measured by multiple reflective or formative indicators (Chin 1998, pp. 305–308). In order to explain variance in an MNC's willingness to use LBS in an analysis which employs both reflective and formative measures and which simultaneously takes into account all six determinants addressed in the hypotheses, we applied the variance-based partial least squares (PLS) structural equation modeling technique (Weiber and Mühlhaus 2010). More specifically, SmartPLS 2.0.M3 was used to calculate reflective and formative measurement as well as structural models.

3.2 Variable Measurements

3.2.1 Willingness to Use LBS

Willingness to use LBS was measured for four application scenarios. They elaborated mobile pull LBS in the fields of information, transaction, navigation and communication (**Table 1**). After introducing a scenario respondents were asked to indicate the likelihood of using the illustrated LBS on a 6-point continuum (footnote d, **Table 1**). In line with Fang et al. (2006), the four items are interpreted as formative indicators of LBS use probability. Stated differently, the dependent criterion is measured as an additive construct embracing the various benefits attributed to four application scenarios. As shown in **Table 1**, the weights of all four indicators exceed 0.10 which is recommended as a threshold value indicating an acceptable quality of measurement (Weiber and Mühlhaus 2010, p. 210). In addition, three indicator weights are statistically significant at the 10% level at least. Since there is no agreement in the literature on whether an elimination of indicators with low loadings is advisable in formative measures (Diamantopoulos et al. 2008, p. 1204), we chose to retain indicator S3 in the measurement model. Overall, the quality of the measurement model of the willingness to use LBS scale may be classified as good.

3.2.2 Determinants of the Willingness to Use LBS

The six potential determinants of the willingness to use LBS were captured by a total of 19 items. In line with previous mobile communication studies (Broeckelmann and Groeppel-Klein 2008, pp. 154–156; Königstorfer 2008, p. 49), past use of mobile data services within the last 12 months was gauged formatively through four indicators addressing the use frequency of various partially mobile network-based services (construct E1 in **Table 2**). The indicator weights exceed the threshold of 0.1, except for the use of a UMTS data card, and reach statistical significance. Nevertheless, in line with the arguments laid out in Sect. 3.2.1 we retain all four items in the measurement model to ensure a sufficient breadth in capturing the construct.

Information needs "on the move" was measured formatively by asking for the frequency of occurrence of everyday situations per month in which three particular types of information would be useful (construct E2 in **Table 2**). The three indicators' loadings exceed the threshold of 0.10. However, the loading of one item (geoinformation) is not statistically significant. In line with our approach applied to the two formative measures in-

[1] To avoid misunderstandings it should be noted, that our empirical analysis and the work of Gerpott (2010) are based on the same survey. However, the two analyses use barely overlapping respondent subsets of the total sample. Furthermore, the articles differ with regard to their focal constructs, measurement models and strategies of statistical analysis (Sect. 3.2).

Table 1 Items and measurement statistics of formative willingness to use LBS scale

Item[a]	Mean[a]	VIF[b]	Weight	*t*-Value[c]
K. Willingness to use LBS (How likely is it that you will use LBS in this situation?)[d]				
S1: On *vacation* in a city you are not familiar with, you are looking for a museum. Your mobile phone provides the opportunity to access a selection of *sights* including respective *short descriptions* and to *navigate to a museum of your choice*.	3.85 (1.65)	1.37	0.53	7.02***
S2: On a *shopping spree* you discover a new LCD-TV you may want to buy. Your mobile phone provides the opportunity to find out where and at what *price* other retailers within a 5 km radius offer the same device.	3.10 (1.78)	1.43	0.16	1.66+
S3: During your *leisure time*, you are traveling with your car on a highway. On the way to your destination, *traffic jams* occur along your route. LBS offer the opportunity to find the most fuel-saving *alternative route* and to suggest optimal change of lanes in case of a traffic jam.	3.49 (1.78)	1.40	0.13	1.17
S4: At the end of a an exhausting week, you are out for dinner with your best friend in your hometown. Via your mobile phone you communicate to your hometown-specific *online community* where you are right now and suggest a neighboring bar. So, other friends, who are in the same online community can meet you up (later).	2.52 (1.66)	1.38	0.47	4.68***

[a]Value in brackets right to the arithmetical mean is the standard deviation of the item. The mean value of the total scale is 3.24 (standard deviation: 1.29; cf. Huber et al. 2007, pp. 110–111)

[b]VIF = Variance inflation factor. VIF $= 1/(1 - R^2)$. R^2 = Coefficient of determination of a regression of the focal item on all remaining items used to capture a formative construct. Cf. Weiber and Mühlhaus (2010, p. 207)

[c]Results of a *t*-test of significance of an indicator's weight. Number of bootstrapping iterations = 2,000

[d]Original wording of items was in German and was translated into English for the present article. For each item, a 6-point answering format was used ranging from "very unlikely" (= 1) to "very likely" (= 6)

$^{+}p \leq 0.10$, $^{*}p \leq 0.05$, $^{**}p \leq 0.01$, $^{***}p \leq 0.001$ (two-tailed)

Table 2 Formative measures of potential determinants of willingness to use LBS – Items and measurement statistics

Construct/item[a]	Mean[a]	VIF[b]	Weight	*t*-Value[c]
E1. *Past use of mobile data services* (Within the past 12 months, how often did you use …)[d]				
– mobile data services	1.65 (1.48)	1.50	0.54	3.53***
– a UMTS mobile phone/data card	1.60 (1.72)	1.36	0.07	0.40
– GPS car navigation	1.88 (1.39)	1.26	0.30	1.78+
– GPS navigation (off-car)	0.86 (1.10)	1.49	0.41	2.33*
E2. *Information needs*[d] (Frequency of everyday situations per month in which the following information could be useful)				
– Directions	1.23 (0.87)	1.26	0.64	5.32***
– Geoinformation (weather, etc.)	1.13 (0.88)	1.30	0.15	1.22
– Locations of other people	0.90 (1.06)	1.17	0.49	4.46***

[a]Value in brackets right to the arithmetical mean is the standard deviation of the item

[b]VIF = Variance inflation factor. VIF $= 1/(1 - R^2)$. R^2 = Coefficient of determination of a regression of the focal items on all remaining items used to capture a formative construct

[c]Results of a *t*-test of significance of an indicator's weight

[d]Original wording of items was in German and was translated into English for the present article. For each item the fol lowing answering anchors were used: "every day" (= 4), "weekly" (= 3), "monthly" (= 2), "less frequent" (= 1) and "never" (= 0)

$^{+}p \leq 0.10$, $^{*}p \leq 0.05$, $^{**}p \leq 0.01$, $^{***}p \leq 0.001$ (two-tailed)

Table 3 Reflective measures of potential determinants of willingness to use LBS – Items and measurement statistics

Construct/item	Mean[a]	Loading	*t*-Value[b]	IR[c]	CR[c]	AVE[c]	DV[d]
E3. *Social influence*[e]					0.86	0.75	0.09
– The *media* often report *positively* on *LBS*.	1.65 (1.39)	0.79	18.19	0.62			
– The *use of LBS* is perceived as a *positive sign of progress* among my friends and acquaintances.	1.69 (1.48)	0.93	66.02	0.86			
E4. *Data privacy risks*[f] (In my opinion . . .)					0.84	0.57	0.32
– . . . I have to reveal too much *personal data* in order to make proper use of LBS.	4.26 (1.54)	0.67	9.64	0.45			
– . . . it is very easy for third parties to *obtain unauthorized access to my personal data*, if I use LBS.	4.19 (1.46)	0.84	31.08	0.70			
– . . . there is a threat that mobile data service providers *abuse* my *data for advertisement*.	5.08 (1.27)	0.77	18.57	0.59			
– . . . the *use of LBS* is associated with a *higher risk of fraud* than other mobile data services (e.g. WAP).	4.01 (1.50)	0.73	55.53	0.53			
E5. *Risk of excessive invoicing amounts*[g] (In my opinion. . .)					0.91	0.83	0.32
– . . . there is a *risk* that LBS use may increase my *mobile services bill to a level higher than acceptable* for me.	4.89 (1.37)	0.91	45.13	0.83			
– . . . *use* of LBS comes along with costs, which are *hard to foresee*.	4.82 (1.29)	0.90	16.25	0.81			
E6. *Trust in mobile network operator*[f]					0.92	0.74	0.04
– My MNO is *honest*.	4.71 (1.27)	0.81	12.83	0.65			
– My MNO *exploits its customers*. (reverse coding)[h]	4.36 (1.32)	0.87	10.78	0.76			
– My MNO behaves *unforeseeable*. (reverse coding)[h]	4.03 (1.36)	0.83	10.48	0.69			
– My MNO is *trustworthy*.	4.44 (1.23)	0.90	16.75	0.81			

[a]Value in brackets right to the arithmetical mean is the standard deviation of the item

[b]Results of a *t*-est of significance of an indicator's weight. All *t*-values are significant at $p \leq 0.001$ (two-tailed)

[c]IR = Indicator reliability. CR = Construct reliability. AVE = Average variance extracted

[d]DV = Discriminance validity. Values in this column are the highest squared correlations of the potential determinants with the remaining reflectively measured variables. For reflective measures discriminant validity is present, if values in this column are lower than the average variance extracted for the respective construct (cf. column "AVE"; Fornell-Larcker-criterion). Cf. Fornell and Larcker (1981, p. 46)

[e]Six response categories varying from "never" (= 0) to "always" (= 5)

[f]Six response categories ranging from "totally wrong" (= 1) to "absolutely right" (= 6)

[g]For each statement, six response categories ranging from "in no case" (= 1) to "for sure" (= 6)

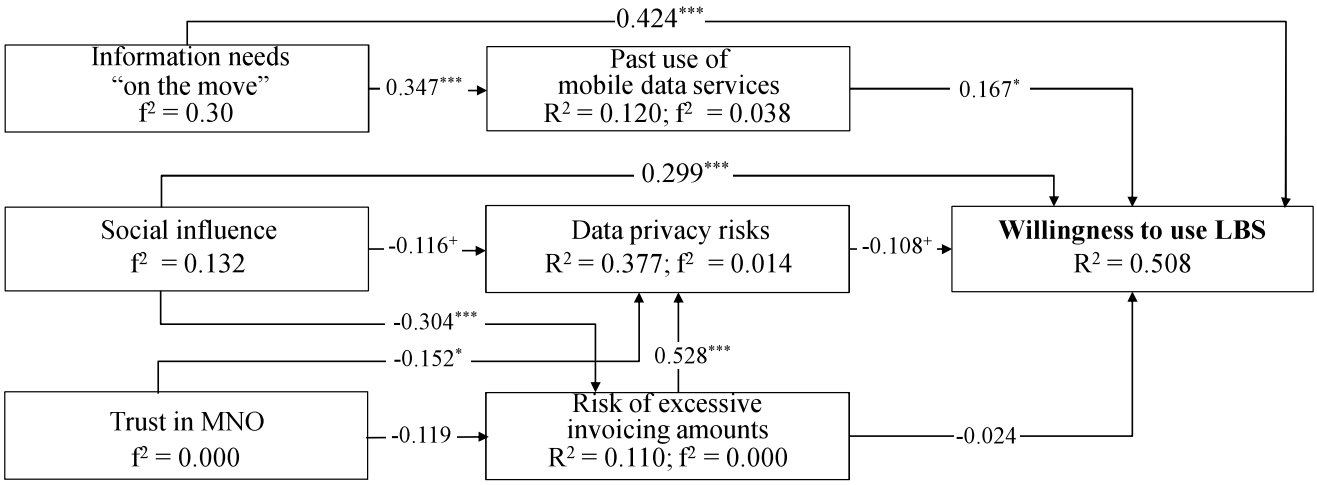
[h]Reverse coding means, that the category "strongly disagree" was scored as 6, and that the category "strongly agree" was scored as 1. Answer categories between the end poles of the scale were changed correspondingly (2 → 5; 3 → 4; 4 → 3; 5 → 2)

troduced above we refrain from eliminating this item.

The evaluation of LBS usage by the respondents' social contacts (= social influence) was captured reflectively by two questions derived from prior studies (Hong et al. 2008, p. 443; Königstorfer 2008, p. 49). These items take both media- and norm-based influences into account (construct E3 in **Table 3**).

The indicator reliabilities exceed the 0.40 threshold recommended by Huber et al. (2007, p. 25). The scale reliability (column "CR" in **Table 3**) of 0.86 is also well above required minimum of 0.60 (Weiber and Mühlhaus 2010, p. 127). Furthermore, the average variance extracted (column "AVE" in **Table 3**) exceeds the value of 0.50 suggested in the literature as an indication of an acceptable measurement model (Fornell and Larcker 1981, pp. 45–46; Weiber and Mühlhaus 2010, p. 139). Hence, the overall quality of this determinants' measurement model may be classified as very good.

Data privacy risks were captured reflectively by four items (construct E4 in **Table 3**) for which several (LBS-)studies (Smith et al. 1996, p. 170; Junglas and Spitzmüller 2006, pp. 5–6; Königstorfer 2008, p. 49; Sheng et al. 2008, p. 375) reported good psychometric properties. The four standard statistics for evaluating the quality of reflective measurement



a) n = 217.
Levels of significance are displayed as follows: + p ≤ 0.1 * p ≤ 0.05 ** p ≤ 0.01 *** p ≤ 0.001 (two-tailed).

Fig. 1 PLS path coefficients, coefficients of determination (R^2) of endogenous constructs and effect sizes (f^2) of the determinants of willingness to use LBS[a]

models exceed required minimum values for the present data privacy risk measure.

The risk of excessive invoicing amounts related to LBS usage was measured by two reflective indicators (construct E5 in **Table 3**) derived from Gerpott (2007). The overall measurement quality of this risk element may be rated as excellent (**Table 3**).

A respondent's trust in one's current MNO was covered reflectively by four indicators (construct E6 in **Table 3**). The items were taken from previous LBS studies of Xu et al. (2005) and Junglas and Spitzmüller (2006) and investigations of online purchase behaviors (Gefen et al. 2003). The quality of the measurement model for this construct again is very high.

As dependent and independent variables are obtained from the same data source, it cannot be ruled out that participants are at least partially aware of the underlying hypotheses and adjust their responses accordingly. In this case, path coefficients of PLS structural models do not reflect true construct associations, but "common method bias" (Temme et al. 2009). However, the bivariate correlations r between the six independent research variables vary from −0.37 (past use of mobile data services – risk of excessive invoicing amounts) to 0.57 (data privacy risks – risk of excessive invoicing amounts). Thus, they reach a level which suggests that a strong "common method bias" is not present in our data. Furthermore, a factor analysis of the 23 study items (**Table 1** to **3**) yielded seven distinct factors with Eigenvalues >1, each with the highest rotated loadings on the items assigned to a construct. These results and the satisfactory discriminant validity of the four independent determinants observed in Fornell-Larcker-tests suggest that variable associations discussed in this research should not be disqualified as a methodological artifact. Consequently, the PLS estimates of the structural model can be used to test the research hypotheses.

4 Empirical Results

Preliminary clues with regard to the tenability of our research hypotheses can be derived by inspecting the bivariate associations between the six independent variables and willingness to use LBS. In line with our propositions, this procedure reveals that only the construct "trust in MNO" had an r of 0.06 with willingness to use LBS, which was *not* statistically significant at least on a 10%-level (two-tailed). The signs of the remaining five coefficients are consistent with the hypotheses and each of the coefficients reaches statistical significance at the 0.1% level (two-tailed). Correlations ranged from −0.24 (risk of excessive invoicing amounts – willingness to use LBS) to 0.54 (past use of mobile data services – willingness to use LBS). Standardized PLS path coefficients for each hypothesis were calculated based on the "path-weighting scheme". **Figure 1** displays these coefficients and their statistical significance tested via a bootstrapping procedure (Chin 1998, pp. 309–320).

The R^2-value of 0.51 indicates that 51% of the variance in willingness to use LBS is explained by the PLS model. In the literature, minimum R^2 threshold values of 0.19 are qualified as "weak", values of 0.33 are considered as "moderate", and values of at least 0.67 are classified as "substantial" in terms of the explanatory power of PLS structural models (Chin 1998, pp. 322–323). Thus, the overall explanatory quality of our structural model is moderate. 10 of the 11 path coefficients exceed the value of 0.10 which the literature suggests as a threshold for substantive interpretation of paths. Five path coefficients even go beyond the more rigorous threshold of 0.20 (Weiber and Mühlhaus 2010, p. 259).

Hypothesis H1, proposing a positive impact of the frequency of current mobile data services usage on willingness to use LBS, is supported in the PLS structural model with a path coefficient of 0.17 which is significant at a 5% level.

According to hypotheses H2 and H3, "information needs on the move" on the one hand are assumed to influence willingness to use LBS directly and on the other hand indirectly, mediated by past use of mobile data services. As depicted in **Fig. 1**, the respective coefficients of the structural model (0.42 and 0.35) clearly exceed the aforementioned minimum values for relevant paths of 0.10–0.20. Thus, the analysis supports H2 and H3 both at a 0.1% level of statistical significance. With an effect size of 0.30 "in-

formation needs on the move" have a strong impact on respondents' willingness to use LBS (Chin 1998, pp. 316–317; Weiber and Mühlhaus 2010, p. 257). Since formative measurements disentangle effects of single indicators on a target construct (Huber et al. 2007, pp. 358–360), the three weights of the information needs items listed in **Table 2** reveal substantial impacts of the need for directions and for other persons' locations on willingness to use LBS.

According to H4 we expected a direct positive impact of the extent of endorsement of LBS use in the social environment of an MNC on willingness to use LBS. The corresponding path coefficient is 0.30 and statistically significant at $p \leq 0.10$. Therefore, H4 is supported. Contrary to H5, the path coefficient of risk of excessive invoicing amounts is only 0.02 and has no statistically significant negative effect on willingness to use LBS. The level of perceived risks of excessive invoicing amounts is in turn significantly reduced as the extent of the MNC's social environments endorsement of LBS use increases (confirmation of H6), but not by an MNC's trust in one's own MNO (rejection of H7).

Hypothesis H8 suggested a significantly negative effect of perceived data privacy risks on willingness to use LBS. The pertinent path coefficient amounts only to -0.11 which is marginally significant at $p \leq 0.10$. Data privacy risks in turn are also only weakly associated with social influence (H9): The relevant path coefficient is -0.12 which is statistically significant at the 10% level. However, in line with H10, data privacy risks are perceived the less severe the stronger the trust in one's own MNO. The respective path coefficient of -0.15 achieves a significance level of 5%. An even considerably stronger effect on perceived data privacy risks is triggered by the perceived risk of excessive invoicing amounts[2]: The structural weight for this path is 0.53 ($p \leq 0.001$). Thus, H11 is clearly supported.

The effect sizes of the six potential determinants of willingness to use LBS (**Fig. 1**) are also reported in **Fig. 1**. A comparative look at these statistics reveals that information needs "on the move" ($f^2 = 0.30$) have by far the strongest impact on the criterion followed by social influence ($f^2 = 0.13$) as the second most important determinant. In addition, past use of mobile data services ($f^2 = 0.04$) and data privacy risks ($f^2 = 0.01$) display still statistically significant but much weaker effects on willingness to use LBS. In contrast, trust in MNO and risk of excessive invoicing amounts do not contribute to explaining differences in willingness to use LBS.

5 Discussion

5.1 Implications for Practitioners

The present investigation surveyed 217 German-speaking MNC in order to shed light on their willingness to use LBS on mobile devices and to explore the contribution of six variables in explaining differences in willingness to use LBS via the PLS method. From a scholarly perspective, the findings imply that Goodhue's and Thompson's (1995) "Task-Individual-Technology-Fit" framework is suited to improve the understanding of some roots of inter-individual differences in willingness to use LBS: Information needs "on the move", reflecting the fit between technical LBS functionality and individual service needs of MNC, turned out to be the most powerful determinant of willingness to use LBS. Furthermore, past use of mobile data services was identified as the third most influential driver of willingness to use LBS. Similar findings were reported by Barkhuus and Dey (2003) and Bouwman et al. (2009). In the context of the TITF framework, past use variable reflects a potential customer's individual capability to properly handle innovative data service offerings.

Out of the remaining four potential determinants, primarily social influence exhibited a significant effect on willingness to use LBS ($f^2 = 0.132$). This suggests that explanation attempts regarding willingness to use new mobile services should not be constrained to a single behavioral theory, but rather that a particularly promising framework should be complemented by plausible theory extensions.

Finally, in substantive terms this study indicates that usage barriers of innovative mobile services (here: data security risks and risks of excessive invoicing amounts) emphasized in prior work (Bouwman et al. 2007) do not contribute substantially to the explanation of an individual's willingness to use new mobile services. These findings imply that the willingness of early adopters to try out innovative mobile services is mainly shaped by benefit/advantage perceptions.

The study's results also have practical implications for the design of marketing campaigns which intend to stimulate demand for LBS in the early adoption phase of market cultivation. According to our findings, MNO planning to initially promote LBS among early adopters and subsequently in the mass market are well advised to focus their marketing efforts on certain customer segments. The most promising segment are people who benefit most from certain types of "on the move" information, due to frequent travelling or extensive leisure time activities spent with others at diverse locations (e.g., stadium) (Groeppel-Klein and Königstorfer 2007, p. 85; Yuan et al. 2010, p. 131). For this segment, vivid examples should be used to highlight advantages of the availability of localized "on the move" content to cover orientation needs arising in unpredictable or deliberately unplanned situations where urgent or highly topical information is crucial. According to our results, this customer segment is predominantly composed of persons who already use other mobile data services and (GPS-based) navigation devices. Assuming that usage intensity of other mobile data services does not change erratically over time (Aaltonen et al. 2005), it may be concluded that MNO should offer LBS specifically to those MNC in their customer base with an above average use intensity of other data services.

The comparison of the effect sizes of the constructs "social influence" and "information needs on the move" suggests that LBS market launch measures should focus initially on observed travel/movement behaviors of MNC. Given the significant effect of LBS evaluations by a customer's close social contacts, it could also be beneficial for MNO to positively influence the image of LBS in a second step. Free LBS trial offers to non-users may trigger positive experiences in this target group, which they may share with their social peers afterwards (Tsai et al. 2009).

Perceived data privacy risks have a weak but significant effect on willingness to use LBS. This result, which is in

[2] Structure weights of a PLS model congruent with the one visualized in **Fig. 1** except for a reverse direction of causality of data privacy risks on risks of excessive invoicing amounts, do not differ materially from the results shown in **Fig. 1**.

Abstract

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Determinants of the Willingness to Use Mobile Location-Based Services

An Empirical Analysis of Residential Mobile Phone Customers

This article develops 11 hypotheses on impacts of six customer characteristics on an individual's willingness to use mobile location based services (LBS). Hypotheses are tested in a sample of 217 mobile communications customers in Germany who participated in a standardized online-survey. PLS analysis suggests that reported frequency of "on the move" information needs, perceived assessment of LBS in a customer's social environment and extent of past use of other mobile data services have statistically as well as practically significant effects on adoption intentions for pull LBS. Data privacy risks and cost/bill size concerns are only weakly or not related to such intentions.

Keywords: Adoption, Consumer behavior, Intention to use, Location-based services, Mobile communications services, Partial Least Squares

line with findings of other LBS studies (Barkhuus and Dey 2003; Lee et al. 2009; Tsai et al. 2009), suggests that data privacy concerns associated with LBS are indeed discussed as an important usage barrier in the academic literature (Xu 2009). In practice, however, these concerns do not form a factor which substantially influences willingness to use *pull* LBS of MNO in Germany. In line with Barkhuus and Dey (2003), Tsai et al. (2009) and Xu (2009) it appears reasonable to assume that customers especially ignore data privacy risks if LBS efficiently support them in managing job-related or private tasks. Therefore, LBS related data security measures of MNO may be seen as a precondition ensuring that legal requirements, such as §96 and §98 of the German "Telekommunikationsgesetz", are carefully met in a way which is clearly visible to customers. However, beyond this, such measures are of little relevance in enhancing the customers' willingness to use pull LBS.

Findings of other LBS studies (Xu 2009), according to which trust in one's own MNO has indirect effects on willingness to use LBS, are not confirmed in our sample. Hence, it may be difficult for MNO to generate a considerable advantage from their established customer relations in competing with non-vertically integrated, specialized LBS providers without own mobile network infrastructure.

5.2 Limitations and Resulting Research Suggestions

The present work helps to improve the understanding of various degrees of willingness to use LBS among MNO residential customers in Germany. Nevertheless, the analysis is subject to several limitations. A major restriction stems from the procedure applied to obtain respondents for our survey and the resulting demographic structure of the sample. It consists of residential mobile services customers who actively navigated to a website with the survey instrument (self-selection). Thus, participants may have a greater interest in LBS than the average customer. Additionally, compared to the total population of MNC in Germany our sample consists of rather young, well-educated and male individuals. Even though PLS coefficients computed for the paths in **Fig. 1** in subsamples separated by age ($\leq$25 versus $>$ 25 years) and level of education (without versus with university degree) do not differ significantly, future work should test the tenability of the present results in samples which better fit with the socio-demographic structure of all MNC in Germany. In addition, a replication of our analysis is desirable in a few years from now because it is likely that future surveys will also include customers who are not among the avantgarde of early LBS adopters.

The present study relied on stated willingness to use LBS but not on actual LBS adoption or usage intensity over time as its dependent criterion. Therefore, future work should examine both use intentions and use behaviors as sequential criteria in a longitudinal study. For LBS providers influencing willingness to use is an antecedent to changing to actual LBS usage. Thus, use willingness is indeed of a considerable practical relevance (Groeppel-Klein and Königstorfer 2007, p. 75). Nevertheless, it is not the only determinant of actual usage behavior. Therefore, a multi-criteria-design would provide insights on how determinants of willingness to use differ from factors driving actual use intensity (Venkatesh et al. 2003, pp. 440–441). For instance, technical service features may have stronger impacts on acceptance processes in early stages, whereas social factors and economic variables may be more important for subsequent LBS usage.

Further, additional research is desirable which looks at relations between additional potential determinants (e.g., LBS tariff plans, individual financial constraints, perceived enjoyment when handling mobile devices) and LBS acceptance criteria. Finally, it is important to explore to what extent weak adoption effects of data privacy concerns observed here for pull LBS hold for *push* LBS (e.g., mobile advertisement).

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