Inf Syst E-Bus Manage (2008) 6:361–384
DOI 10.1007/s10257-007-0074-9

ORIGINAL ARTICLE

User requirements of mobile technology: results from a content analysis of user reviews

Judith Gebauer · Ya Tang · Chaiwat Baimai

Published online: 7 December 2007

Abstract Advanced mobile technology continues to shape professional environments. Smart cell phones, pocket computers and laptop computers reduce the need of users to remain close to a wired information system infrastructure and allow for task performance in many different contexts. Among the consequences are changes in technology requirements, such as the need to limit weight and size of the devices. In the current paper, we focus on the factors that users find important in mobile devices. Based on a content analysis of online user reviews that was followed by structural equation modeling, we found four factors to be significantly related with overall user evaluation, namely functionality, portability, performance, and usability. Besides the practical relevance for technology developers and managers, our research results contribute to the discussion about the extent to which previously established theories of technology adoption and use are applicable to mobile technology. We also discuss the methodological suitability of online user reviews for the assessment of user requirements, and the complementarity of automated and non-automated forms of content analysis.

Keywords Mobile devices · Mobile business users · Online user reviews · Requirements engineering · Usability · Content analysis

J. Gebauer (✉) · Y. Tang
College of Business, University of Illinois at Urbana-Champaign,
350 Wohlers Hall, 1206 South Sixth Street, Champaign, IL 61820, USA
e-mail: gebauer@uiuc.edu
URL: http://www.judithgebauer.com

Y. Tang
e-mail: yatang2@uiuc.edu

C. Baimai
College of Business Administration, Texas A&M International University,
5201 University Blvd, Laredo, TX 78041-1900, USA
e-mail: cbaimai@students.tamiu.edu

1 Introduction

Developments of mobile information technology are characterized by ongoing technological progress and by growing diffusion, in particular in professional use settings (Computerworld 2003). In order to fully understand the opportunities that are presented by mobile technology and to ensure the success of the necessary investments, it is important to develop a thorough understanding about the conditions of success, and the impacts on user performance (Mennecke and Strader 2003).

Scholars of information systems have long sought to explain and predict the success of information technology with theories, such as the technology acceptance model and the theory of task-technology fit. According to the technology acceptance model, the intention to use information technology is associated most significantly with the two user-perceived variables of usefulness and ease of use of the technology (Davis 1989; Davis et al. 1989). The application of the technology acceptance model to technology innovations, such as the World Wide Web (Lederer et al. 2000; Moon and Kim 2001) and Internet-shopping (Gefen et al. 2003; Gefen and Straub 2000) supported the suggested relevance of both factors: usefulness and ease of use. While usefulness typically provided the strongest explanation for intention to use (and actual use), conflicting results were obtained by different scholars regarding the impact of user-perceived ease of use. Explanations for the discrepancies and subsequent extensions of the technology acceptance model include the consideration of intrinsic versus extrinsic characteristics (Gefen and Straub 2000), trust (Gefen et al. 2003), and differing requirements for different tasks (Fang et al. 2005–2006).

In comparison, scholars of the theory of task-technology fit focused on actual technology use and performance impacts, and investigated the characteristics and the explanatory power of the fit between the technology and the user-task that the technology supports (Goodhue and Thompson 1995; Zigurs and Buckland 1998). Applications of the theory of task-technology fit to technology innovations, such as Web-commerce (D'Ambra and Wilson 2004), mobile electronic procurement (Gebauer and Shaw 2004), and mobile commerce in the insurance industry (Lee et al. 2007), have provided empirical evidence for the ability of task-technology fit to help explain and predict the success of innovative information systems. A recent research study of wireless technology acceptance found variations of technology requirements, depending on specific user tasks (Fang et al. 2005–2006).

A systematic analysis of the requirements that are associated with the business use of mobile technology from a practical, design-related perspective is currently outstanding. Such an analysis, however, can make an important contribution to the success of mobile technology and of the associated investments. In the current paper, we focus on user-perceived system requirements, a concept that has been studied and categorized by scholars of software engineering, and of usability. We present an exploratory research study that seeks to identify factors that are related to the overall user evaluation of mobile technology devices that target business users. We rely on the fact that technology users increasingly make their voices heard, as they publish reviews and discuss advantages and shortcomings of various products

in online forums, thus, providing a continuous stream of rich data. For this study, we analyzed user reviews of four mobile devices: a smart cell phone, two personal digital assistants, and a laptop that were posted on an online media website (CNET). The content analysis yielded a total of 49 comment categories that we grouped into five explaining factors: functionality, performance, portability, usability, and network accessibility; a dependent variable of overall evaluation; and two control items: device and user experience. Structural equation modeling using partial least squares estimation showed that four of the five explaining factors were associated significantly with the overall evaluation of the four devices.

In the following sections, we position our research study with respect to two related areas of research: requirements engineering and usability. We then discuss our chosen methodology of non-automated content analysis of online reviews and describe the development of the database to be analyzed. The results of our data analysis are presented in section four. Section five discusses the results with respect to the practical implications, the applicability of previous approaches of information systems research to mobile information systems, and the complementarity between non-automated and automated content analyses as a basis for continuous monitoring. Section six provides concluding remarks regarding the limitations of the current study, and an outlook to future research.

2 Related research

Two areas of research are particularly relevant to the current study. The first area of research is requirements engineering—an essential element of software engineering that guides the evaluation of software quality. The second area of research that is relevant to our study is usability with its socio-technological perspective that examines the interface between an information system and the user including the use context.

2.1 Requirements engineering

Requirements engineering is an essential element of software design and development, whereby the careful specification of requirements is considered critical to ensure a high level of software quality (Yourdon 1989). Requirements engineers often distinguish between functional and non-functional requirements (Wiegers 2003). Functional requirements pertain to the particular behaviors of a software system that are inherent in the different functions that the system can perform. To the extent that functional requirements determine what the system can do they also determine the extent to which user tasks can be supported. In contrast, non-functional requirements support the functional aspects of a system in a more general sense, and relate to the operation of the system. Typical non-functional requirements, sometimes also referred to as "ilities", are reliability, scalability, usability, system performance, and costs. To the extent that non-functional

requirements relate to the conditions of the use context they may impose constraints on the design and implementation of the system.

ISO 9126, an international standard for the evaluation of software, classifies software quality based on the six characteristics of functionality, reliability, usability, efficiency, maintainability, and portability between technology platforms. Multiple perspectives have been acknowledged, such as the perspectives of organizational management, user, developer, and operator. However, the main focus of requirements engineering is on technology, in line with the intention to ensure the development of high-quality software, manifested for example in the efficient operation and maintenance of the resulting systems.

2.2 Usability research

Requirements engineering is complemented by research and practice that focus on usability as an important aspect of human–computer interaction. Within the broader context of product development, usability is associated with the ease with which people can employ a tool or other human-made object in order to achieve a particular goal (Nielsen 1994). Usability studies complement the technological perspective of requirements engineers with a more user-centric approach that includes aspects related with the psychology and physiology of the user, and with the specific use context (Shneiderman 1980). Among the goals of usability experts are the elegance and clarity with which the interaction between a user and a computer program is designed.

The definition of usability and the distinction of the elements that usability implies are not without ambiguity. For example, the International Organization for Standardization (ISO) has defined usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO 9241–11), thus encompassing goal-related (i.e., functional) and non-functional aspects, related for example to the use context. In contrast, researchers of human–computer interface (Shneiderman 1980) and usability (Nielsen 1994) have distinguished between usability and utility, and have pointed out that both concepts together comprise usefulness, which is again suggested to be an important antecedent of system acceptance. The ambiguity of the definitions notwithstanding, we note the conceptual relatedness of user tasks (associated with goals and utility) on the one hand, and use context (associated with usability) on the other hand, that re-emphasizes the complementarity of functional and non-functional system characteristics.

Mobile Internet technologies have long been notorious for poor usability. For example, Buchanan et al. (2001) found mobile Internet technologies based on the wireless applications protocol (WAP) standard to provide a poor user experience based on the fact that they were difficult to use, and lacked flexibility and robustness. The authors provided suggestions of how to improve effectiveness and usefulness on a small screen with a user-centered approach. To support mobile consumer electronic commerce, Chan et al. (2002) developed guidelines for content presentation, search, and navigation systems intended to overcome design

constraints and to provide adequate support for various tasks. Insights about the specific needs of mobile business users have been provided by Perry et al. (2001). In an interpretive research study of mobile workers who traveled internationally from the UK, the authors analyzed context and activities, and emphasized the use of various electronic and non-electronic information and communication tools and technologies. Functional requirements that were identified in the study included: support for planful opportunism to make sure that documents and information were available during a trip in the appropriate form when and where needed; effective use of "dead" time to avoid work overload when returning to the office; use of the mobile phone as a device "proxy" based on the flexibility that was provided with the phone and that allowed the mobile worker to call the home office to access information system resources and ask to act on their behalf: "While it may not be the perfect tool, the [mobile] phone allows the mobile worker to achieve important goals without investing a lot of effort in locating or carrying specialized information or communications appliances with them" (p. 340); and use of technology for remote awareness monitoring for both the traveler and the stationary colleagues back at the office. The importance of the use context of mobile Internet was confirmed in a usability research study by Kim et al. (2002). The authors emphasized their finding that different use contexts present unique usability problems.

3 Methodology

Online customer reviews have become a convenient and increasingly important source of information about customer requirements, product characteristics, and market responses that is used by product developers, customers, and researchers alike (Hui and Liu 2004a, b; Wei et al. 2006). In a research study of the impact of professional and amateur reviews on the box office performance of movies Zhang and Dellarocas (2006) found that star ratings of online reviews may be associated with an increase of over 4% in box office revenues.

3.1 Automated versus non-automated content analysis

The interpretation of customer reviews is often based on content analysis, whereby two basic approaches to coding have been applied: (1) non-automated coding by humans; and (2) automated coding that is performed partially or fully by computer software. For a human-coded schema, coders classify text according to a specific set of classification categories. Validity and reliability of text classification needs to be demonstrated based on the consistency of the coding results. Computerized methods use individual-word-count systems and artificial intelligence systems to automatically classify text by assigning words to pre-specified semantically equivalent categories. Compared to human coded content analysis, computerized methods can result in higher stability and reliability of the coding scheme, formal comparability of the results, and higher efficiency and ease with which large volumes of

qualitative data can be processed. Limitations of computerized methods concern validity, as it is difficult for an automated scheme to understand the broader meaning of a text and to recognize the communicative intent of word usage in a specific context. Research studies have shown that computerized methods did not perform more accurate in coding the symbolic meaning of a text than manual methods (Morris 1994; Rosenberg et al. 1990; Weber 1990). In addition, it is important for an automated coding scheme to be exhaustive as text outside of the coding scheme cannot be correctly identified. In general, both techniques can be considered as complementary insofar as automated coding relies on input generated by non-automated coding.

3.2 Data collection

The current research study is exploratory. Rather than using a predefined survey with questions that were formulated based on previous research, we applied an inductive approach that relied on the interpretation of online user reviews. Since the reviews were essentially unsolicited, it may be assumed that the comments are particularly helpful to identify requirements that are important to individual users.

Data were gathered from http://www.cnet.com an online media website that allows its visitors to publish technology reviews. The site provided a large amount of relevant data that were readily available, as well as a homogeneous publishing environment. We analyzed reviews of four technology products, namely a smart cell phone, two personal digital assistant (PDA) devices, and an ultra-light laptop. The devices were selected based on (1) the capability of the device to support business users, as stated in technology reviews that were published in the trade-press (online and offline) and as based on reported market share; and (2) popularity in the CNET online community, as indicated by the number of posted reviews, the number of site visitors who indicated the review to be useful, the number of comments on the reviews, and replies to comments. To ensure comparability of the technologies, we focused on devices that were introduced into the market during 2005, followed by reviews that were posted in 2005 to early 2006. For each of the four devices, between 19 and 44 reviews were analyzed in the order that the reviews were listed on the website, which by default was according to the number of visitors who indicated they found the respective review useful. We performed a content analysis of reviews for the second PDA-device initially because only a limited number of reviews were available for the first PDA, a device that—based on market share—was particularly popular among business users. We subsequently kept the interpretations of both PDA-devices in the analysis for two reasons: First, both sets of comments contributed to our sample size, and thus, helped to strengthen the statistical significance of the data analysis. Second, comparing the reviews of two devices can be helpful to distinguish issues that are related to a device and technology, from issues that are related to a particular brand and model.

The fact that several reviews were backed by a large number of site visitors (in some cases over 100) who indicated the respective review to be useful, may help to offset the limitation of self-selection that is inherent in the current research setup.

By relying on the comments of users who chose to voice their opinions online, we could only capture issues that are of importance to that particular user group, and may have missed some of the issues that are of importance to users who chose not to share their opinions online. We note the need to address this shortcoming in subsequent research studies.

3.3 Database development

To develop a database of coded user reviews we iterated two steps: (1) development of a classification scheme that included the identification and description of comment categories; and (2) coding that included the classification and rating of the user reviews according to the classification scheme. The process was initiated by the first coder (first author) who initially developed a classification scheme that included elements from theories of user adoption and use, such as the technology acceptance model, and the theory of task-technology fit (Gebauer and Ginsburg 2008). The coder also determined coding guidelines, and subsequently prepared a first set of ratings of the user reviews. Soon, it became apparent that the overlap was limited between the elements that were derived from the suggested theories and the user comments: A number of issues that are essential to the theories were not discussed in the reviews, such as user-tasks, actual use, and impacts on task-performance. In contrast, a number of issues that were of concern to the reviewers were not part of the respective theories, in particular issues related to the technical performance of the devices. The classification scheme that eventually emerged resembles categorization schemes that have been developed by scholars of requirements engineering and usability (see Appendix).

In order to improve the reliability of the interpretations and replicability of the research study, the second coder (third author) was instructed about the research purpose, provided with an annotated classification scheme, and then proceeded to interpret and code the user reviews independently. Regular discussions throughout the coding process that lasted about three months helped to uncover ambiguous descriptions of comment categories and coding guidelines, and also helped to ensure the completeness of the categories in relation with the user reviews. The second author subsequently served as a third coder and performed an independent analysis of all reviews, followed by a comparison with the ratings of coders one and two, and the opportunity for revision. For the remaining differences in coding, average ratings were included in the database. In addition, an inclusive approach was applied to include comments that had been identified by one or two coders only, and to allow a comment to appear in more than one category if determined so by any of the three coders.

The content analysis resulted in a classification scheme of 49 items. In addition to comments on a number of functional and non-functional features of the respective device, the scheme included categories pertaining to overall evaluation, and information about previous experience with the device and technology. With one exception, each comment category was rated on a five-point scale, ranging from strongly negative to strongly positive. The numerical rating of one category was

provided by the reviewers as part of the reviews, using a scale from one to ten. Table 1 provides examples of coding, comments, and the corresponding classification scheme. Descriptions of all comment categories and coding guidelines are provided in the Appendix.

Consistency of the interpretations between the coders was important to ensure high quality of the resulting database and replicability of the research study. Table 2 details the extent to which the interpretations of the three coders were correlated for instances where two or three coders agreed on the relevance of a comment for a particular comment category in the classification scheme. Table 3 details the extent to which the interpretations of the three coders were correlated when including instances where only one or no coder determined a comment to be relevant for a particular comment category. To determine the correlations in Table 3, all missing values (i.e., empty cells in the matrix categorizing reviews into comment categories) were replaced with a value of "0". While all correlations are significant at the

Table 1 Example coding, comments, and classification scheme (source: user technology reviews published on http://www.cnet.com)

Coding	Example comment	Classification scheme (in brackets: corresponding factor)
5: Strongly positive	"This [device] is unarguably the best I have owned"	Overall user evaluation
	"The size [is] truly amazing"	Form factors (portability)
4: Positive	"Keyboard is really comfortable"	Keyboard (usability)
	"Smooth operating system, quite stable"	Stability (performance)
3: Neutral	"The screen on the [device] isn't as lustrous as other [devices] and doesn't have that glossy look to it, but to me it does just fine."	Display (usability)
	"As mp3 player, quality is okay, not excellent, but enough to be happy and listening music on the plane."	Support during travel (portability)
2: Negative	"I had trouble with email, email settings and sending attachments too."	Messaging communication (functionality)
	"The keys are a little too close together"	Input (usability)
1: Strongly negative	The [device] "just sucks when it comes to the personalization of menus… [and that] just frustrates the hell out of me"	Customization and adaptability (usability)
	"Terrible reception… Soft resets, hard resets, loading and unloading software, even using it without 3rd party software. Nothing has improved the phone reception."	Network access and reception (network capability)

Table 2 Inter-rater reliability: Pearson correlations between coder ratings; missing values not replaced

	Coder 1	Coder 2	Coder 3
Coder 1	1 (1,396)		
Coder 2	0.789** (827)	1 (975)	
Coder 3	0.828** (1,094)	0.844** (887)	1 (1,307)

In brackets: number of data points (n)

** $p < 0.01$

Table 3 Inter-rater reliability: Pearson correlations between coder ratings; missing values replaced by "0"

	Coder 1	Coder 2	Coder 3
Coder 1	1 (6,912)		
Coder 2	0.677** (6,912)	1 (6,912)	
Coder 3	0.781** (6,912)	0.761** (6,912)	1 (6,912)

In brackets: number of data points (n)

** $p < 0.01$

$p < 0.01$ level, correlations were higher for the analysis that excludes ratings where the coders could not agree on the relevance of a comment for a particular comment category.

The coding results reflect stronger agreement between the coders with respect to the individual ratings once a comment had been determined relevant for a particular category in the classification scheme, than when including omissions as well. The coding results furthermore reflect a learning process, given that the ratings of the third coder were correlated higher with the ratings of coders one and two than the correlations between coders one and two who performed their ratings earlier. The fact that all correlations were below 0.85 reflected the difficulty and limits of the coding procedure as a result of the high degree of freedom associated with the review interpretations. The results also highlight the need for concise category descriptions, possibly as part of an ongoing learning process.

4 Data analysis and results

4.1 Research model

To analyze the collected data in a meaningful way with a research model, we needed to reduce the 49 comment categories into a smaller set of factors. In a related study that used the same set of user reviews, but that included the interpretations of coders one and two only, Gebauer and Ginsburg (2008) performed an exploratory factor analysis. The analysis yielded five profiles that were associated roughly with

different purposes of the devices, such as support for voice communication, support for mobile office, and support for knowledge work. To deepen our understanding of the user reviews, we took a slightly different approach in the current study, and grouped the comment categories of the classification scheme conceptually into five factors, using as guidelines frameworks that have been developed by scholars of requirements engineering and usability (Nielsen 1994; Wiegers 2003). We associated all comment categories that related to the various functions of the devices with one factor: functionality; and associated the comment categories that related to various non-functional features with four additional factors: portability (reflecting the effort required to carry the device), operational performance, usability, and network capability. Three comment categories related to the overall evaluation of the devices, which we used as the dependent variable in the research model, similar to Gebauer and Ginsburg (2008). We expected each of the five functional and non-functional factors to be associated significantly and positively with the dependent variable of overall evaluation. As two control variables we included into the analysis the type of device and self-reported user experience with the device or technology.

4.2 Structural equation modeling

The dataset that resulted from the content analysis of online reviews was characterized by a large number of empty cells that posed some difficulty for data analysis (Chiu and Wolfe 2002). In order to limit the effects of sparsity in the dataset, only categories were kept for analysis that were mentioned in more than 15% of reviews (as averaged per device, see Appendix). In addition, all missing values were replaced with the neutral rating of "3", and the reviews of PDA1 were weighted with a factor of 2 in order to obtain roughly equal shares of all four devices (un-weighted sample sizes are 44, 19, 40, and 41, for cell phone, PDA 1, PDA 2, and laptop, respectively).

We analyzed the dataset with structural equation modeling (SEM), using partial least squares (PLS) estimation to asses the impacts of the five factors and two control variables that were identified in the content analysis, on the overall evaluation of the mobile devices (Fig. 1 below). PLS has several advantages over other covariance based SEM methods. First, PLS is generally better suited for purposes of theory development where pre-validated variable constructs may not be available, such as in our case. Second, PLS does not rely on the assumption of a normal distribution of variables, a possible concern in our study as well. Third, PLS can apply both reflective and formative modeling, whereby we consider a formative model to be more appropriate for our study. Reflective measurement indicators are viewed as affected by the underlying latent variable and as a result they covariate with the latent variable. In comparison, formative indicators are believed to cause changes in the latent variable. Consequently, the indicators in formative models will approximate the underlying construct in combination, whereby individual weights are determined according to the relative importance in forming the construct. Formative indicators are not necessarily correlated, as would be expected in a

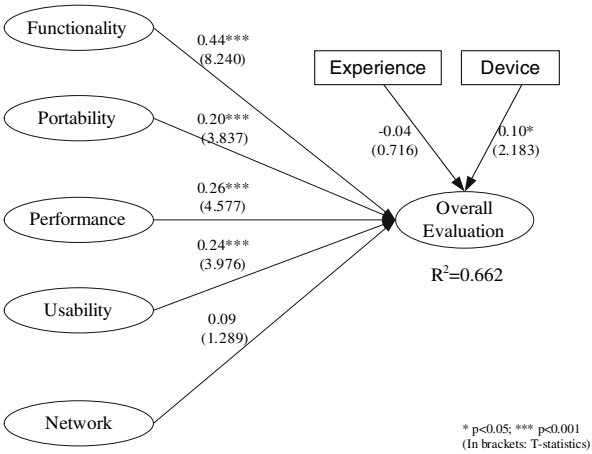

Fig. 1 Structural model

reflective model. A good example for a formative indicator is provided by the measurements that are included to assess social economic status (SES), such as gender, age, education, income, and occupation. Any change in the measurement indicators can result in a change of SES, but the individual indicators may not be correlated.

In our model, the latent variables of functionality, portability, performance, usability, network, and overall evaluation were all modeled as formative constructs based on the assumption that the indicators (i.e., comment categories) measured different aspects of the respective latent variables, and were not necessarily correlated. The middle columns of Table 4 show the descriptive statistics for the indicators that were used in the analysis. All items ranged from 1 to 5, with the exception of OVE1 (rating)—the scale of which ranged from 1 to 10. Table 5 shows the inter-correlations among the latent variables.

Besides the descriptive results, Table 4 also shows the weights for the formative indicators in the measurement model. The weights depict the relative importance of the indicators in defining the formative constructs. While no minimum threshold values for indicator weights have been established, the *T*-statistics can be used to determine the relative importance of the individual formative indicators. Table 4 shows that based on the *T*-statistics, FUN1 (voice), FUN3 (information access), and FUN6 (entertainment) were significant indicators of functionality with FUN1 (voice) being the dominant indicator; both POR1 (form factors) and POR2 (need to carry) were significant indicators of portability; PER2 (compatibility), PER3 (battery) and PER4 (speed) were significant indicators of performance; five out of seven indicators (display, keyboard, customer service, ease of use and internal sound) were significant indicators of usability; and both NET1 (network access) and NET2 (bluetooth) were significant indicators of network. OVE3 (price/value) was not a significant indicator of overall evaluation.

In PLS, the predictive power of the model is assessed based on the R^2 value of the structural model. R^2 can be interpreted, similarly to regression analysis, as the variance explained by the independent variables. The results of our structural model

Table 4 Measurement model: descriptive statistics and weights of formative indicators (weighted $n = 163$ for all indicators and variables; missing values replaced with neutral value of "3")

Measurement indicators	Label	Mean	Standard deviation	Weight	Standard error	*T* statistic
Functionality						
FUN1	Voice	3.16	0.86	0.83***	0.07	11.98
FUN2	Messaging	3.09	0.53	0.13	0.10	1.26
FUN3	Information access	3.18	0.55	0.30**	0.10	2.97
FUN4	Productivity	3.07	0.45	0.06	0.10	0.58
FUN5	Multifunctionality	3.25	0.50	0.01	0.09	0.12
FUN6	Entertainment	3.07	0.45	0.24*	0.11	2.09
FUN7	Camera	3.07	0.41	0.08	0.11	0.73
Portability						
POR1	Form factors	3.43	0.76	0.68***	0.15	4.53
POR2	Need to carry	3.19	0.45	0.57***	0.16	3.50
Performance						
PER1	Stability	2.92	0.52	0.18	0.12	1.43
PER2	Compatibility	2.94	0.52	0.62***	0.10	6.22
PER3	Battery	3.05	0.63	0.23*	0.10	2.29
PER4	Speed	3.21	0.64	0.56***	0.13	4.35
PER5	Storage	2.97	0.38	0.09	0.12	0.73
Usability						
USA1	Display	3.44	0.78	0.45***	0.09	4.82
USA2	Keyboard	3.13	0.63	0.21*	0.10	1.97
USA3	Design	3.34	0.73	0.09	0.11	0.83
USA4	Customer service	2.88	0.63	0.36**	0.12	3.09
USA5	Ease of use	3.16	0.64	0.24*	0.10	2.27
USA6	External sound	3.04	0.55	0.14	0.11	1.20
USA7	Internal sound	2.97	0.52	0.45***	0.11	3.93
Network						
NET1	Network access	3.27	0.67	0.74***	0.12	6.26
NET2	Bluetooth	3.06	0.48	0.63***	0.15	4.10
Overall evaluation						
OVE1	Rating	6.90	2.70	0.46***	0.09	4.92
OVE2	Overall	3.69	1.15	0.58***	0.08	7.11
OVE3	Price, value	2.94	0.59	0.06	0.10	0.62

See the Appendix for a more detailed description of the indicators

* $p < 0.05$

** $p < 0.01$

*** $p < 0.001$

Table 5 Correlation of latent variables

	Functionality	Portability	Performance	Usability	Network	Overall evaluation	Device
Portability	−0.03						
Performance	0.28	0.34					
Usability	0.54	0.16	0.33				
Network	0.42	0.02	0.18	0.45			
Overall evaluation	0.63	0.36	0.54	0.60	0.40		
Device	−0.23	0.28	0.07	−0.11	0.14	0.05	
Experience	0.23	0.03	0.08	0.20	0.23	0.15	0.07

indicated that as much as 66.2% of the variance of overall evaluation could be explained by the latent variables (Fig. 1), indicating considerable consistency of the reviews and of our interpretation. For each of the latent variables of functionality, portability, performance and usability, we found a significant positive relationship with overall evaluation at the 0.001 level of significance (*T*-statistics of path coefficients are shown in brackets). Among the latent variables, functionality had the strongest influence on overall evaluation, followed by performance, usability, and portability. The relationship between network and overall evaluation, however, was insignificant. Regarding the control variables, we found the results to vary significantly according to device, but not according to the level of user experience.

5 Discussion

With the current research study, we set out to identify user requirements of mobile devices that target mobile business users. Based on a non-automated content analysis of online user reviews of four devices that included a cell phone, two PDAs, and an ultra-light laptop, we identified a number of indicators that were grouped into five latent variables, four of which were associated significantly with the overall evaluation of the devices.

In our dataset, the latent variable of functionality appeared to be the best predictor of overall evaluation, whereby voice communication was the most important measurement item in addition to information access (Internet and Web browsing) and entertainment. Our results largely confirm the findings reported in earlier research studies, for example to explain the level of adoption of various wireless applications (Lopperi and Sengupta 2004). The particular importance of voice communication as a requirement for mobile devices was also in line with Perry et al.'s (2001) findings regarding the mobile phone as a highly versatile tool that can serve the mobile user as a proxy for other information and communication devices. The relevance of entertainment-related functionality as one of only three significant indicators of the latent variable, however, appeared to reflect the fact that

from the perspective of the individual user—and not necessarily in line with the perspective of the organization—mobile technology needs to serve business-related as well personal purposes. The significant predictive power of the non-functional factors of portability (form factors and limited weight to carry) and usability (most notably display, and internal sound related to voice communication) reflected the relevance of the use context for the overall evaluation of mobile technology (Kim et al. 2002) and the need for the careful management of usability (Buchanan et al. 2001; Chan et al. 2002).

Of the two control variables that were included in the research model, one—device—had a significant effect on overall evaluation, whereas the other one—user experience—had not. The results of our data analysis, thus, reflected significant variations of the requirements regarding the mobile technology devices and highlight the need to distinguish between different types of mobile technology (see Gebauer and Ginsburg 2008 for additional details). With respect to user experience, our results contrasted a conceptual framework that was developed to explain the adoption of mobile technology and the transition that individual users make from a stationary desktop environment to mobile technology (Schwarz et al. 2004). Whereas Schwarz et al. (2004) suggested significant impacts of user experience on adoption and transition processes, the results of the current research study showed little variation for different levels of previous user experience.

Besides the immediate practical relevance of the indicators and factors that we identified as important for overall user evaluation and for the design and assessment of mobile technology devices, the results of the current research study have implications for information systems research. The need to carefully address the question to what extent previous conceptual frameworks and theories can be applied to mobile technologies and a mobile use context has been pointed out elsewhere (Mylonopoulos and Doukidis 2003). Our findings re-emphasized in particular the need to include into the analysis the mobile use context via non-functional requirements, and the need to distinguish between various mobile technology artifacts (devices).

With respect to the sampling method, our analysis showed clearly the need for non-automated content analysis. We developed a rich classification scheme based on continuous and intense interaction between three coders. The resulting database lent itself well for analysis with a formative structural equation model, as indicated by the high R^2. We feel that the considerable effort that was associated with manual coding was essential in order to capture the key requirements of the mobile devices that were included in the analysis. We found online user reviews to be full of abbreviations, colloquial expressions, and non-standard spelling (intentional and non-intentional) that were inherently difficult or even impossible to capture with an automated coding scheme. In addition, the reviews were comparatively short (sometimes only a few sentences), thus, making interpretation difficult. Despite their shortness, the reviews often addressed many different aspects in relation with the individual reviewer's experience and personal situation. The resulting high level of interpretive freedom became apparent in the limits to inter-rater reliability that was reported in the current study.

6 Concluding remarks

Based on a content analysis of online reviews, the current research study identified a number of concrete functional and non-functional requirements of importance to the users of mobile technology devices. The findings can help inform technology development and technology management, as well as inform the application of information systems theory to mobile technology. Several limitations of our study, however, related for example to a limited sample size of 144 reviews (out of many thousands of reviews that are available online) and a sampling method that included user self-selection and a large degree of interpretive freedom, indicate a need to continue the research efforts.

Since the classification scheme and factors were derived inductively they closely reflect the underlying set of online user reviews. As result of our chosen methodology, we cannot claim the lists to be exhaustive or to overlap fully with earlier frameworks. In addition, and despite many discussions between the three coders, differences in interpretation of the reviews remained that concerned the categorization as well as the ratings of the individual comments. Even though all of the correlations between the ratings of the three coders were significant at the $p < 0.01$ level, inter-rater correlations never surpassed a level of 0.85—a result that effectively limits the stability of the dataset and the possibility for data analysis. The limits to inter-rater reliability also emphasized the importance for careful development of a classification scheme that would be suitable for the automated analysis of online user reviews. In addition, non-automated content analysis is inherently limited in the amount of data that can be processed efficiently, limiting the possibility for large-scale and ongoing observation of developments in a market that is characterized by large product variety and dynamic change. We are hopeful that our derived classification scheme will provide a useful basis for subsequent coding that can eventually be performed automatically and continuously on a larger sample. Automated and continuous analyses that include a number of similar, competing devices promise to help distinguish issues of temporary concern because of unexpected characteristics of a particular model from issues that are of more general concern related to the devices. In any case, the coding scheme needs to be updated frequently for an ongoing analysis to be effective. With the current study, we emphasize the complementarity of automated and non-automated content analyses as a basis for the continued analysis of highly dynamic technological developments.

The dataset may be considered incomplete insofar as we were not able to extract information about a number of issues that are important to comprehend the use context and use patterns of mobile technology for business purposes (Gebauer and Ginsburg 2008). For example, little information was provided regarding the tasks that users performed with the mobile devices; actual use in terms of frequency, intensity or functionality; and impacts on individual and organizational performance. In other words, the current study found online reviewers to focus primarily on particular functions and features of the devices and did not provide much additional information regarding the purpose and context of use. Such issues will need to be captured with other methods of data sampling, including case studies,

interviews, and surveys. The issues identified in the current study, may, however, provide information systems researchers with a very important basis for subsequent studies, as they represent topics and themes that users are particularly willing to talk about. We expect our findings to help improve survey response rates and help assess the quality of survey results.

A number of avenues for future research present themselves based on the results and on the limits of the current study. First, at least some of the issues that we identified appear to be related closely to what is on top of the mind of the online reviewers and may be of temporary concern, such as customer service issues and the instability associated with a particular product release. Our analysis included two competing PDA devices that showed considerable differences not only regarding the ratings, but also regarding the issues that were mentioned by the reviewers (Gebauer and Ginsburg 2008). We suggest that subsequent research studies include a number of similar devices in order to offset for factors that are particular to a specific brand or model. Second, the list of functional and non-functional requirements that we identified as relevant for user evaluation can provide a solid basis for subsequent analysis. If based on computer-supported coding schemes, ongoing interpretations of online user reviews may be performed on a larger scale, and may contribute greatly to understand (1) the user needs associated with mobile technology devices, and (2) the dynamic changes in relation with ongoing technological developments. Third, given its great level of detail, the current list of requirements can support subsequent research studies based on sampling methods such as interviews, case studies and quantitative surveys. Fourth, the concrete insights derived in the current study promise to inform the application, and possibly extension, of earlier information systems theories to mobile information systems. Such theories include the theory of task-technology fit, and the technology adoption model that have been developed within the context of non-mobile technologies, and that typically utilize variables and constructs at a higher level of abstraction. Again, the implications of dynamic changes associated with technological change and with increasing user mobility will have to be taken into consideration.

Acknowledgments We thank Alfred Hubler for feedback and guidance. A related paper was presented at the Fifth Workshop on e-Business (WeB 2006), and we thank reviewers and participants for helpful comments. All errors remain our own.

Appendix

Below, we provide the coding scheme for online user reviews of mobile technology that was developed as part of the current research study. The scheme is based on 144 reviews of four devices that included a smart cell-phone ($n = 44$), two PDAs ($n = 19$, $n = 40$), and one ultra-light laptop ($n = 41$). The percentages that are reported in the first column of the table below were calculated as the averages of four devices, thus giving equal weight to each device. For the data analysis with SEM, we approximated equal weights by assigning a weight of two for each review

of PDA 1. As a result of the weighting, Table 4 reports a weighted sample size of $n = 163$.

Category (% reviews, average of four devices)	Description	Rating
Overall evaluation		
Rating (100%)[a]	Reviewer provides a numeric rating on a scale from 1 to 10	1: Abysmal; 10: Excellent
Overall performance (88%)[a]	Reviewer comments on the overall quality of the technology (system or device) without giving more specific details on functionality, form factors, etc.	1: Overall performance of technology is extremely poor 5: Overall performance of technology is extremely good
Price, value (35%)[a]	Reviewer comments on the value of the technology, including the price for a device and related contracts	1: Value of the technology is extremely poor; 5: Value of the technology is extremely good
Control variable		
User experience (64%)[a]	Reviewer reports previous experience with similar technology and devices (e.g. previous models of the same device, competitor products and comparable forms of mobile technology), comments on the fact that he/she might have used or managed similar technology and devices, referring to the number of models, or to a particular length of time	1: Reviewer has no experience with similar technology; 5: Reviewer has great experience with similar technology
Functionality		
Voice communication (54%)[a]	Reviewer comments on the quality of the technology to support voice communication	1: Quality of support for voice communication is extremely poor; 5: Quality of support for voice communication is extremely good
Messaging communication (29%)[a]	Reviewer comments on the quality of the technology to support written communication, including email, instant messenger, and multimedia messaging	1: Quality of support for messaging communication is extremely poor; 5: Quality of support for messaging communication is extremely good
Information and data access (28%)[a]	Reviewer comments on the quality of the technology to enable access and a process information provided on private intranets and the public Internet and World Wide Web	1: Quality of support for information and data access is extremely poor; 5: Quality of support for information and data access is extremely good

Appendix continued

Category (% reviews, average of four devices)	Description	Rating
Personal productivity (24%)[a]	Reviewer comments on the quality of the technology to help stay organized, such as by maintaining a calendar, task lists, and personal address book	1: Quality of support for personal productivity is extremely poor; 5: Quality of support for personal productivity is extremely good
Multifunctionality (23%)[a]	Reviewer comments on the availability and quality of support for a variety of different uses (functionalities)	1: Multifunctionality is extremely poor or non-existent; device is extremely specialized; 5: Multifunctionality extremely good; device supports many different uses (functionalities) well
Entertainment and multimedia applications (23%)[a]	Reviewer comments on the quality of the technology to support entertainment and multimedia applications, including watching, making, and editing movies; watching TV; storing and listening to music; editing and looking at pictures; playing games	1: Quality of support for entertainment and multimedia applications is extremely poor; 5: Quality of support for entertainment and multimedia applications is extremely good
Camera, video, audio recorder (20%)[a]	Reviewer comments on the availability and the quality of an integrated camera, video, and audio recorder, including resolution of pictures and videos taken	1: Quality of integrated camera, video and audio recorder is extremely poor; 5: Quality of integrated camera, video and audio recorder is extremely good
Alerts (13%)	Reviewer comments on the quality of the alerts that are provided by the system, e.g., including comments on the availability of various types of alerts (ring tone, vibration, visual cues)	1: Quality of alerts is extremely poor; 5: Quality of alerts is extremely good
Support for business purposes (12%)	Reviewer comments on the quality of the support provided by the technology for work and business purposes	1: Quality of support for business purposes is extremely poor; 5: Quality of support for business purposes is extremely good
Office applications (12%)	Reviewer comments on the quality of the technology to support office applications, such as word processing, presentation, spreadsheet, database, and other interactive applications (e.g. programming)	1: Quality of support for office applications is extremely poor; 5: Quality of support for office applications is extremely good
Video and audio player (9%)	Reviewer comments on the availability and the quality of an integrated video player and audio player	1: Quality of integrated video and audio player is extremely poor; 5: Quality of integrated video and audio player is extremely good

Appendix continued

Category (% reviews, average of four devices)	Description	Rating
Voice dialing (8%)	Reviewer comments on the availability and quality of voice dialing, including voice recognition	1: Quality of voice dialing is extremely poor; 5: Quality of voice dialing is extremely good
Support for personal purposes (4%)	Reviewer comments on the quality of the support provided by the technology for non-work-related (personal) purposes	1: Quality of support for personal purposes is extremely poor; 5: Quality of support for personal purposes is extremely good
Document manage-ment, attachment processing (3%)	Reviewer comments on the availability and quality of document management attachment processing capabilities	1: Quality of document management and attachment processing is extremely poor; 5: Quality of document management and attachment processing is extremely good
Voice mail (2%)	Reviewer comments on the availability and quality of voice mail features	1: Quality of voice mail is extremely poor; 5: Quality of voice mail is extremely good
Support for continuous and immediate access to computer and network resources, and to perform work promptly (1%)	Reviewer comments on the quality and extent to which the technology allows for continuous and immediate access to computer and network resources, independent of the particular type of resource (Internet/Web, intranet, databases) or application	1: Quality of support for continuous and immediate access to computer and network resources is extremely poor; 5: Quality of support for continuous and immediate access to computer and network resources is extremely good
Support for immediate and constant interaction with various communication partners, and to perform work promptly (1%)	Reviewer comments on the quality and extent to which the technology allows for prompt and continuous interaction with various communication partners, such as clients, customers, staff, colleagues, business partners, family, and friends, independent of the particular type of communication (voice, messaging, etc.)	1: Quality of support for prompt and continuous interaction with various communication partners is extremely poor; 5: Quality of support for prompt and continuous interaction with various communication partners is extremely good
Non-functional features related to portability and ubiquitous use of the device		
Form factors (60%)[a]	Reviewer comments on the physical device in terms of size weight, general built-quality (e.g., sturdiness) and layout (e.g., buttons and ports)	1: Quality of form factors is extremely poor; 5: Quality of form factors is extremely good

Appendix continued

Category (% reviews, average of four devices)	Description	Rating
Limited equipment to be carried (19%)[a]	Reviewer comments on the extent to which the device limits the total weight and/or number of pieces of equipment to be carried along while mobile	1: Technology does not limit the total weight and/or number of pieces of equipment to be carried along while mobile; 5: Technology greatly limits the total weight and/or number of pieces of equipment to be carried along while mobile
Adaptability and customizability (14%)	Reviewer comments on the extent and quality with which technology can adapt automatically to changes of location (location awareness), for example enabled by the ability to adjust time when entering a different time zone and by the availability of Global Positioning System (GPS) functionality, and/or be customized according to personal preferences, including menus, background themes, buttons, ring-tones, etc.	1: Technology cannot adapt automatically or be customized by the user; 5: Technology adapts automatically or can be customized extremely well by the user
Support during travel (12%)	Reviewer comments on the quality of support during travel	1: Quality of support during travel is extremely poor; 5: Quality of support during travel is extremely good
Support during commute (10%)	Reviewer comments on the quality of support during commute	1: Quality of support during commute is extremely poor; 5: Quality of support during commute is extremely good
Support while working on location (7%)	Reviewer comments on the quality of support during work on location	1: Quality of support during work on location is extremely poor; 5: Quality of support during work on location is extremely good
Support while telecommuting (5%)	Reviewer comments on the quality of support during telecommuting (i.e. working from non-office locations, such as from home)	1: Quality of support while telecommuting is extremely poor; 5: Quality of support while telecommuting is extremely good
Support while having limited access to power (4%)	Reviewer comments on the quality and the amount of time of which the technology can be used while having limited access to power	1: Technology cannot be used while having limited access to power; 5: Technology can be used extremely well while having limited access to power

Appendix continued

Category (% reviews, average of four devices)	Description	Rating
Support where network connection is limited or unavailable (2%)	Reviewer comments on the quality with which the technology can be used while having limited access to network connection, including situations of low bandwidth, unstable connections, as well as situations where there is no wireless Internet (Wifi) and/or no cell phone reception	1: Technology cannot be used while having limited network connection; 5: Technology can be used extremely well while having limited network connection
Support while having limited time to work and concentrate on particular location (1%)	Reviewer comments on the extent to which the technology can be used while being distracted due to background noise and other factors that compete for the reviewer attention, and on the extent to which technology can be used for (very) limited periods of time, e.g., while waiting for a plane	1: Technology cannot be used while being distracted, and during very limited periods of time; 5: Technology can be used extremely well while being distracted, and during very limited periods of time
Non-functional features related to operation and performance		
Links and compatiblity w/other devices (34%)[a]	Reviewer comments on the compatibility of the technology with other devices and systems, related to physical connections (e.g., availability of various ports), and software-related (e.g., related to synchronization)	1: Technology does not link with other technologies 5: Technology links extremely well with other technologies
Speed (33%)[a]	Reviewer comments on the performance (speed, responsiveness) of the technology in general, mainly as a result of the strength of the processor	1: Quality of performance is extremely poor; 5: Quality of performance is extremely good
Battery (33%)[a]	Reviewer comments on the life of the battery, on the availability of extended batteries, and on the availability of power saving features	1: Quality of battery is extremely poor; 5: Quality of battery is extremely good
Stability (24%)[a]	Reviewer comments on the stability of the technology in general and on the operating system in particular	1: Technology is extremely unstable; 5: Technology is extremely stable
Storage (24%)[a]	Reviewer comments on the amount of available storage in the form of a hard disk, onboard memory and availability of disk drives; also includes comments on the extendibility of storage	1: Quality of storage extremely poor; 5: Quality of storage is extremely good

Appendix continued

Category (% reviews, average of four devices)	Description	Rating
Operation (15%)	Reviewer comments on the operation of the technology, e.g., on the noise from a fan during operation and heat generated by the device	1: Quality of operation extremely poor; 5: Quality of operation is extremely good
Non-functional features related to usability and appearance		
Display (49%)[a]	Reviewer comments on the quality of the output displayed by the technology including the quality of the screen and (size, resolution, color depth, brightness) and the performance of the graphics and video card	1: Quality of output devices is extremely poor; 5: Quality of output devices is extremely good
Keyboard (48%)[a]	Reviewer comments on the ease with which information can be keyed into the system, including use of the keyboard, mouse, buttons, and also including the availability of shortcuts	1: Quality of input devices is extremely poor; 5: Quality of input devices is extremely good
Design (41%)[a]	Reviewer comments on the overall quality of the design, including aesthetics, colors, shapes, etc. of the devices	1: Design is extremely poor; 5: Design is extremely good
Customer service (39%)[a]	Reviewer comments on the level and quality of customer service received from the manufacturer, retailer, and service provider, including comments on responsiveness, replacement, warranty, and contract	1: Customer service is extremely poor; 5: Customer service is extremely good
Ease of use (34%)[a]	Reviewer comments on the usability of the system, referring to menu structures but also to the usability of buttons and other hardware-related features	1: Ease of use is extremely poor; 5: Ease of use is extremely good
External sound (20%)[a]	Reviewer comments on the quality of the speakers to be used by a phone (speakerphone), as well as for videos and music	1: External sound quality is extremely poor; 5: External sound quality is extremely good
Internal sound (17%)[a]	Reviewer comments on the internal sound quality of the phone feature	1: Internal sound quality is extremely poor; 5: Internal sound quality is extremely good

Appendix continued

Category (% reviews, average of four devices)	Description	Rating
Backlight of screen and keyboard (13%)	Reviewer comments on the availability and the quality of a backlight for the keyboard and the brightness of the screen, allowing for the use in very dark and in very bright environments	1: Quality of backlight is extremely poor; 5: Quality of backlight is extremely good
Non-functional features related to network connectivity		
Network access and reception (35%)[a]	Reviewer comments on the availability and quality of network access (including bandwidth), and on the level of reception provided by the device and service provider (if applicable)	1: Quality of network access and reception is extremely poor; 5: Quality of network access and reception is extremely good
Bluetooth (25%)[a]	Reviewer comments on the availability and quality of wireless connections of the device with other devices (e.g. headset, printer, modem, PC), and the ease with which such connections can be set up and managed	1: Quality of hands-free features (Bluetooth) is extremely poor; 5: Quality of hands-free features (Bluetooth) is extremely good
WiFi (10%)	Reviewer comments on the availability and quality of wireless Internet (WiFi) features	1: Quality of WiFi is extremely poor; 5: Quality of WiFi is extremely good

[a] Item included in subsequent analysis

References

Buchanan G, Farrant S, Jones M, Thimbleby H, Marsden G, Pazzani M (2001) Improving mobile internet usability. In: Shen VY, Saito N, Lyu MR, Zurko ME (eds) Proceedings of the tenth international World Wide Web conference ACM, New York, pp 673–680 (available at http://www10.org/cdrom/papers/230, accessed 15 August 2007)

Chan SS, Fang X, Brzezinski J, Zhou Y, Xu S, Lam J (2002) Usability for mobile commerce across multiple form factors. J Electron Commer Res 3(3):187–199

Chiu CWT, Wolfe EW (2002) A method for analyzing sparse data matrices in the generalizability theory framework. Appl Psychol Meas 26(3):321–338

Computerworld (2003) Executive briefings: the wireless corporation. Strategic Insights from the Editors of Computerworld

D'Ambra J, Wilson CS (2004) Explaining perceived performance of the World Wide Web: uncertainty and the task-technology fit model. Internet Res 1(4):294–310

Davis FD (1989) Perceived usefulness, perceived ease of use, and user acceptance of information technology. Manag Inf Syst Q 13(3):319–339

Davis FD, Bagozzi RP, Warshaw PR (1989) User acceptance of computer technology: a comparison of two theoretical models. Manag Sci 35(8):982–1003

Fang X, Chan S, Brzezinski J, Xu S (2005–2006) Moderating effects of task type on wireless technology acceptance. J Manag Inf Syst 22(3):123–157
Gebauer J, Ginsburg M (2008) Exploring the black box of task-technology fit: the case of mobile information systems. Commun ACM (in press)
Gebauer J, Shaw MJ (2004) Success factors and impacts of mobile business applications: results from a mobile e-procurement study. Int J Electron Commer 8(3):19–41
Gefen D, Straub D (2000) The relative importance of perceived ease of use in IS adoption: A study of e-commerce adoption. J Assoc Inf Syst 1(8)
Gefen D, Karahanna E, Straub DW (2003) Trust and TAM in online shopping: an integrated model. Manag Inf Syst Quart 27(1):51–90
Goodhue DL, Thompson RL (1995) Task-technology fit and individual performance. Manag Inf Syst Quart 19(2):213–236
Hui M, Liu B (2004a) Mining and summarizing customer reviews. In: Proceedings of the 10th ACM SIGKDD international conference on knowledge discovery and data mining, Seattle, pp 168–177
Hui M, Liu B (2004b) Mining opinion features in customer reviews. In: Proceedings of the nineteenth national conference on artificial intelligence (AAAI-04), San Jose, pp 755–760
Kim H, Kim J, Lee Y, Chae M, Choi, Y (2002) An empirical study of the use contexts and usability problems in mobile Internet. In: Proceedings of the 35th Hawaii international conference on system science, Big Island, Hawaii
Lederer AL, Maupin DJ, Sena MP, Zhuang Y (2000) The technology acceptance model and the World Wide Web. Decis Support Syst 29:269–282
Lee C-C, Cheng HK, Cheng HH (2007) An empirical study of mobile commerce in insurance industry: task-technology fit and individual differences. Decis Support Syst 43:95–110
Lopperi K, Sengupta S (2004) Are we ready? The state of wireless e-business in the USA. Inf Syst e-Bus Manag 2:293–307
Mennecke BE, Strader TJ (2003) Mobile commerce: technology, theory, and applications. Idea Group, Hershey
Moon J-W, Kim Y-G (2001) Extending TAM for a World-Wide-Web context. Inf Manag 38:217–230
Morris R (1994) Computerized content analysis in management research: a demonstration of advantages and limitations. J Manag 20(4):903–931
Mylonopoulos NA, Doukidis GI (2003) Introduction to the special issue: mobile business: technological pluralism, social assimilation, and growth. Int J Electron Commer 8(1):5–22
Nielsen J (1994) Usability engineering. Morgan Kaufmann, San Francisco
Perry M, O'Hara K, Sellen A, Brown B, Harper R (2001) Dealing with mobility: understanding access anytime, anywhere. ACM Trans Comput Hum Interact 8(4):323–347
Rosenberg SD, Schnurr PP, Oxman TE (1990) Content analysis: a comparison of manual and computerized systems. J Pers Assess 54(1–2):298–310
Schwarz A, Junglas IA, Krotov V, Chin WW (2004) Exploring the role of experience and compatibility in using mobile technology. Inf Syst e-Bus Manag 2:337–356
Shneiderman B (1980) Software psychology: human factors in computer and information systems. Winthrop, Cambridge
Weber RP (1990) Basic content analysis. Sage, Newbury Park
Wei C-P, Chen Y-M, Yang C-S, Yang CC (2006) A semantic-based approach to supporting product feature extraction from customer reviews. In: Proceedings of the fifth workshop on e-Bus, Milwaukee
Wiegers K (2003) Software requirements. 2nd edn, Microsoft, Seattle
Yourdon E (1989) Modern structured analysis. Yourdon, Englewood Cliffs
Zhang M, Dellarocas C (2006) The lord of the ratings: how a movie's fate is influenced by reviews. In: Proceedings of the twenty-seventh international conference on inf syst, Milwaukee
Zigurs I, Buckland B (1998) A theory of task-technology fit and group support system effectiveness. Manag Inf Syst Quart 22(3):313–334