USING THE KANO MODEL TO IDENTIFY ATTRACTIVE USER-INTERFACE SOFTWARE COMPONENTS

Completed Research Paper

Jörg H. Mayer
University of St.Gallen
Institute of Information Management
Mueller-Friedberg-Strasse 8
9000 St.Gallen
Switzerland
joerg.mayer@unisg.ch

Abstract

Understanding user preferences for interacting with information systems (IS) is particularly important in the field of management support systems (MSS), where strong idiosyncrasies must be considered. As user-interface software components are highly visible to managers, this article examines which components make mobile MSS attractive. We consider both “consumer-” and “analyst-type” managers and examine component attributes for smartphones, tablets, and notebooks. Based on a literature review, we lay out managers’ user-group preferences. Then, applying the Kano model – often employed in total quality management to discover categories of customer needs – we use findings from an expert focus group to define most satisfying mobile MSS software components. Finally, we provide five design guidelines for mobile workplaces that meet managers’ needs: managing hyperconnected information retrieval, setting up context-aware computing, replacing keyboard and mouse with natural dialog control, implementing machine learning for simulation and recommendation engines, and leveraging embedded collaboration for wicked problems.

Introduction

Mobility and its implications for user interfaces in information systems (IS) is currently one of the most visible trends for research in human-computer interaction (HCI) to address (Ladd et al. 2010; Sears and Jacko 2007). Because companies expect mobile IS to make their workforce – including their managers – more efficient, they are looking to bring even their internal processes into a post-PC era.

Companies’ mobile IS efforts go back to 2003, when Research in Motion (RIM) launched its first BlackBerry smartphone, which enabled managers to both make phone calls and handle e-mails using a tactile keypad. However, the most recent developments were driven by the consumer market, when Apple launched the iPhone in 2007 and the iPad in 2010. With their multi-touch, direct-manipulation user interfaces, these devices should be interesting for business in light of two trends. First, digital natives increasingly populate organizations along with digital immigrants, who learned to engage with IS as adults and developed into mobile IS users over the years (Vodanovich et al. 2010). These new-generation managers more naturally accept IS, but also have higher expectations about how these systems should accommodate their individual user preferences. Second, thanks to technical progress in recent years, even senior managers should be able to operate IS themselves (Wixom and Watson 2010). As a result, IS use factors are gaining importance as HCI researchers (and IS engineers) recognize how much easy-to-use, intuitive user interactions with IS determine their success (Marchand and Peppard 2008).

ISO 9241-110 (2008) defines interactive IS as a combination of software and hardware components that receive input from users and communicate output in order to support them in performing their tasks. User interfaces “[...] are what users see and work with to use a product” (Hackos and Redish 1998, p. 1). They are a combination of software components that conform to a model composed according to a standard (Council and Heinemann 2002). Simplifying IS handling, software components evolved over the last 20 years from text fields, buttons, menus, and tiny icons to a palette of IS functionalities, such as exception reporting, collaboration, and context-sensitive “do more” functions (Tidwell 2005). End-user devices (hereafter referred to as devices), in turn, are the physical elements of IS handled by users (Laudon and Laudon 2010). Today, smartphones, tablets, and the more-established notebooks (including tablet PCs, ultrabooks, etc.) stand out (Gartner 2011).

We focus on user-interface software components (referred to below as software components) as they are highly visible to managers (Büyüközkan 2009). Because research on software components for mobile management support systems (MSS) is fairly underrepresented (Sumita and Yoshii 2010), we take this IS domain as our example. Under these considerations, the objective of this article is to examine software components that make mobile MSS attractive. We consider components for both “consumer-” and “analyst-type” managers and examine their attributes for smartphones, tablets, and notebooks. In doing so, we answer three research questions:

- What user-group preferences exist among managers?
- What software components accommodate these user-group preferences best?
- What design guidelines should shape mobile workplaces for managers?

The classification of software components forms a model for better MSS design. The design guidelines, in turn, contribute to theories specifying how MSS should be designed based on kernel theories (Kuechler and Vaishnavi 2008). Consequently, our approach follows the rising tenets of design science research in HCI (Benbasat 2010; Hevner and Chatterjee 2010). Applying Peffers et al.’s (2006) process model, we motivate our research by identifying gaps in user-interface designs for mobile MSS and suggest software components to address them. After revisiting foundations, we lay out our research model. Based on a literature review, we arrive at managers’ user-group preferences and MSS software components that basically accommodate them. After revisiting foundations, we lay out our research model. Based on a literature review, we arrive at managers’ user-group preferences and MSS software components that basically accommodate them. Applying the Kano model, we use findings from an expert focus group to determine which of these software components most satisfy managers. We then synthesize, implement, and discuss our findings in one-on-one manager interviews to provide five guidelines for shaping mobile workplaces for managers. The article concludes with a summary and avenues of future research.
Foundations

Since Ackoff’s pioneering work in 1967, managers and IS to support them have been a constant topic of interest to researchers. Both the terms “MSS” (Clark Jr et al. 2007) and “decision support systems” (DSS, Arnott and Pervan 2008) have been proposed as labels for IS intended to support managerial tasks. Since DSS evolved from a specific concept that originated as a complement to management information systems (MIS) and overlapped in the late 1980s with executive information systems (EIS, Power 2008), we refer to our object of study as MSS. This more general term covers MIS, DSS, EIS, and, more recently, knowledge management systems (KMS) and business intelligence (BI) systems (Carlsson et al. 2009; Watson 2009). Pernici (2006) states that mobile IS are “[…] information systems in which access to information resources and services is gained through terminals that are easily moveable in space, operable no matter what the location.” Based on Puuronen and Savolainen (1997) we define mobile MSS as IS offering “[…] all the necessary IS services when managers are traveling.”

An accepted IS theory from HCI, cognitive fit (Vessey 1991), states that decision making is efficient and effective when a problem is presented in line with an individual’s approach to problem-solving (Vessey and Galetta 1991). Also known in IS design is the theory of task-technology fit (TTF, Goodhue 1995). It is a user-evaluation construct for IS success and describes the degree to which system characteristics accommodate user tasks – the higher the TTF, the better the IS fits user requirements (Goodhue and Thompson 1995). More recently, studies by Gebauer focusing on mobile IS have gained broader recognition (Gebauer 2008; Gebauer et al., 2010). Following Liu et al. (2011), such models aid understanding of IS fit in terms of what factors should be included in an IS model, while ignoring how these factors interact with one another. Furthermore, while these models help to understand IS phenomena, they do not directly give advice for the design of (innovative) artifacts (Gregor and Jones 2007).

Ideally, MSS design would meet the requirements of all potential managers, but in reality researchers must find a balance between extreme standardization and extreme individualization (Winter 2011). IS designed purely for deployment using a “plan, build, run” model can no longer adequately address this issue (Marchand and Peppard 2008; Marchand and Kettinger 2011). "IS design for use" could provide a way to achieve such a balance (Winter 2011). So, following the TTF theory and taking the task of managing a company, we propose examining managers’ use situations as a starting point for our interface design. MSS use situations represent distinct classes of user-group preferences among managers (Winter 2011). User preferences, in turn, describe differences in the ways individuals want to use IS. They result in requirements for how IS should provide functions or services.

User preferences are particularly important for MSS design because the higher managers are positioned within an organization, the more likely they are to have multifaceted work experience that nurtures a highly individual attitude toward IS. Mobile MSS in particular promise users new freedom to assess, generate, and disseminate information beyond the desktop PC, but they are subject to limiting factors such as smaller screens, electronic rather than tactile keyboards, reduced processing power, and location-dependent connectivity (Tarasewich et al. 2008). Furthermore, mobile MSS must be accessible to users distracted by noise, disruptions, and being on the move (Gebauer et al. 2010). User preferences have been a topic of IS research since the 1970s. Mayer and Mohr 2011 outlines that, as early as 1979, Zmud (1979, p. 975) echoed several authors to assert that “individual differences do exert a major force in determining IS success.” Just a few years later, however, Huber (1983) threw cold water on this approach for many years to come. He claimed that accommodating user preferences requires IS designers to consider too many characteristics and that, in the future, IS might be completely configurable by users anyway. The last 20 years invalidate Huber’s line of argument. In particular, the technology acceptance model (TAM) by Davis (1989) and the IS success model (DeLone and McNeal 2003) prove that user preferences play a predominant role in IS success.

Research Model

Multidimensional MSS Design Framework

Bearing in mind the criticism of fit models, we propose a multidisciplinary framework to structure our literature research. The following citations extend our prior work (Mayer et al. 2011; Mayer and Mohr...
Managers’ User-Group Characteristics in MSS Design

Phase A. User model: A first group of publications deals with individual cognitive styles and covers techniques for user-group segmentation (A.1). Two of the most popular and widespread techniques are the Myers-Briggs Type Indicator (Myers 1976) and Witkin’s concept of field-dependence and field-independence (Witkin et al. 1977). The first classifies an individual’s personality according to four dichotomies: attitude, perceiving function, judging function, and lifestyle. The latter suggests that field-dependent individuals perceive data in their context as a whole and are less attentive to detail (less analytical). Field-independent people, in turn, pay more attention to details (highly analytical).

A second group of publications covers user-group characterization (A.2). These studies either apply the techniques employed in the group above to differentiate characteristics that have an impact on MSS (e.g., women vs. men, Powell and Johnson 1995) or they utilize an explorative procedure to identify groups of managers and their “typical” MSS usage. Tractinsky and Meyer (1999) provide an example of the first approach when they claim that MSS users are not only in a receiving, but also a presenting role and demonstrate that a managers’ objective – such as facilitating decision making – has an impact on his or her preferred user interface design. The second approach is evident in a current study among executives from companies listed in the FT “Europe 500.” Mayer and Stock (2011) report two basic working styles among C-level executives: analysts and consumers.

As these publications show, a number of authors provide methods to differentiate individual cognitive styles (A.1), and even more consider characterizations of user groups (A.2) and their associated MSS usage. Thus, we propose that the influence of individual user-group preferences must be considered in our research model, which collectively refers to the individual variables constituting managers’ user preferences as working style (Figure 1).

2011) by adding references for mobile MSS and appropriate software components. Leveraging research on HCI (Zhang et al. 2002), we begin our literature systematization with a user model (Figure 1, top). To complement our findings, we follow enterprise engineering (EE, Hoogervorst 2009; Dietz 2007) and separate the process of MSS design into two stages (Figure 1, middle). The black-box model describes managers’ perspective on MSS as users. The white-box model considers the constraints on IS design from the engineering perspective. We use requirements engineering (RE) to structure the functional requirements. To specify the MSS software components, we distinguish between a generic solution level, which covers abstract domains of MSS design, and a solution instance level (Figure 1, bottom, Lee et al. 2011). To be applied in practice, generic solutions must be instantiated for situated MSS functionalities (MSS variants 1-n). Figure 1 summarizes the structure of our literature research.

In line with Webster and Watson (2002), we focused on leading IS research outlets for our literature review and selected ten journals based on the catalog provided by the LSE (Willcocks et al. 2008). We expanded our list with proceedings from ICIS and ECIS, and also included publications from five journals on systems and software engineering and four computer science (CS) journals. Additionally, our search covered six HCI journals. Using ABI/INFORM Complete, EbscoHost, Emerald ManagementXtra 150, JSTOR, New Palgrave Dictionary of Economics, ScienceDirect, and SpringerLink, our keyword search string “MSS” or “MIS, DSS, EIS, BI, KMS” and “use” or “IS style, pattern, adoption, acceptance” and “software component” or “exception reporting, navigation/dialog control, information analysis, communication/collaboration” on titles and abstracts resulted in 1,443 hits, of which we found 23 to be relevant. A final backward search led to a total of 50 relevant publications (Figure 1).


Phase B and C. Black-box and white-box model: MSS literature provides several methods for determining information needs as a starting point for domain-specific requirements (B.1). However, none of these proposals consider connections between user-group preferences and MSS design. Several publications examine the implications of user-group preferences on cross-domain (functional) requirements (B.2). For example, Walstrom and Wilson (1997) find that converts use MSS to access predefined reports, sources outside the company, company news, and the latest updates on key performance indicators. Deriving functional principles for MSS design (B.3), Eckerson and Hammond (2011) produce a list of most-wanted functions, such as drillable charts or one-click access. In terms of constructional requirements (C.1), Walia and Carver (2009) classify errors that occur during the requirements phase and develop a taxonomy of human, documentation, and process errors. Turning to constructional principles (C.2), software engineering generally deals with approaches to IS architecture (Sommerville 2010). To take account of the working situations in which managers use MSS, we incorporate their MSS use case into our research model. And because managers’ MSS access also influences their IS usage, we incorporate their MSS access mode into our configuration model as well (Figure 1).
**Existing Studies Fail to Cluster MSS Software Components**

*Phase D. MSS configuration:* Since organizations have become larger and more dispersed, managers are increasingly mobile workers (Vodanovich et al. 2010). However, most publications following the black-box model focus solely on layouts for desktop PCs (Wu et al. 2011). In doing so, Warmouth and Yen (1992) structure software components into information presentation, dialog control, and analytical functions that managers can operate by themselves. Besides Gebauer et al. (2010) and Tarasewich (2008), Yuan et al. (2010) examine the fit between mobile work and IS along the dimensions of mobility, location dependency, and time criticality. But overall, the publications we reviewed either provide lists of software components without a rigorous basis for their selection (Eckerson and Hammond 2011, Papageorgiou and de Bruyn 2010) or examine attributes of a single software component only (Marx et al. 2011). Just two articles consider managers’ MSS use situations and their software components (Arnott and Pervan 2008; Mayer and Mohr 2011). The articles on “IS design for use situations” stay on a generic level (Winter 2011). Thus, a ready-to-use model to examine software components that make mobile MSS attractive is lacking. Most important, we did not find a method for clustering MSS user interface software components to examine which ones clearly drive managers’ user satisfaction and which ones users take for granted.

**Leveraging the Kano Model**

To provide a method to rank MSS software components, we propose a new step for HCI research: applying the Kano model (Kano et al. 1984), which is usually employed in product development to discover categories of customer needs. Based on Herzberg et al. (1959), who distinguish motivators that increase workspace satisfaction from hygiene factors that merely cause dissatisfaction when absent, the Kano model offers an understanding of how customers evaluate products. It thus helps researchers to focus on attractive quality attributes that improve products from a customer perspective (Chen et al. 2010). As shown in Figure 2, we transfer the Kano model to MSS user interface design and differentiate five categories of software components. They influence managers’ IS perception as follows (Matzler und Hinterhuber 1998):

1. **Attractive MSS software components (“A”)** disproportionately influence managers’ satisfaction and act as the strongest differentiators in design. Although managers do not expect IS to include these MSS software components, they are generally very excited about IS that offer these features.
2. **One-dimensional MSS software components (“O”)** result in satisfaction when present and in dissatisfaction when absent. Their presence increases IS performance – “the more, the better.” As these software components improve, satisfaction among most managers increases in a linear (one-dimensional) relation.
3. **Must-have MSS software components (“M”)** are taken for granted by managers. If they are absent, managers will be strongly dissatisfied. However, no matter how well they perform, these basic MSS components do not have the power to shift managers’ user satisfaction beyond a neutral state.
4. Our model groups software components managers do not care about one way or another into the indifferent (“I”) category.
5. For software components in the “reverse” category (“R”) a high degree of achievement actually results in dissatisfaction. For example, the presence of too many functions in a mobile MSS can be perceived as reverse quality, especially by users who like easy-to-use IS handling.

These five types of software components are classified by means of a Kano questionnaire containing a pair of questions for each MSS software component. The first question determines managers’ response to a software component with a proposed attribute (functional question). The second question concerns their response to the same software component without this attribute (dysfunctional question, Figure 2, left). The managers can answer as follows: [1] I dislike the software component and, thus, I will not use it. [2] I do not like this software component, however, I can live with it. [3] I am neutral. [4] It must be that way. This software component is a basic one every device should have. [5] It is a great differentiator that I would not have expected: I like it that way very much. By combining the two answers in the Kano evaluation table (Figure 2, middle) all software components can be classified in one of the five Kano clusters of MSS satisfaction (Figure 2, right).
Based on the findings from our literature research, we arrived at the following twelve software components, which we classify in three respects (Table 1, Warmouth and Yen 1992). Each component attribute is listed along with the functional/dysfunctional question pair used to test and rate it (following section).

<table>
<thead>
<tr>
<th>No</th>
<th>Software component</th>
<th>Functional and dysfunctional form of MSS user satisfaction</th>
<th>Explanations and references from our literature research</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MSS entry</td>
<td>1.1 If the entry point to your mobile device is organized as exception reporting, how do you feel? If exception reporting is NOT included, how do you feel?</td>
<td>Exception reporting consists of a picture, headline, and teaser followed by “read more” (newspaper style, item 1.1, Giner et al. 2009), symbols lead to single reports (“Apple style,” item 1.2, Gebauer and Shaw 2004).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.2 If the entry point to your mobile device is organized with symbols leading to single reports, how do you feel? If such symbols are NOT included in your devices, how do you feel?</td>
<td>Blair-Early and Zender (2008) stress visualizing information graphically to encourage manager interaction with IS.</td>
</tr>
<tr>
<td>2</td>
<td>Visualization</td>
<td>2.0 If the visualization on your device is primarily graphical, how do you feel? If such visualization is NOT included, how do you feel?</td>
<td>Eckerson and Hammond (2011) show that bar charts are the most preferred way to present information, followed by line charts (3.1) and other, more complex graph types such as waterfall, tachometer, spider charts, etc. (3.2).</td>
</tr>
<tr>
<td>3</td>
<td>Graph type</td>
<td>3.1 If the prevalent graph type is a bar/line chart, how do you feel? If NOT, how do you feel?</td>
<td>Blair-Early and Zender (2008) stress visualizing information graphically to encourage manager interaction with IS.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.2 If the prevalent graph type is more complex, how do you feel? If NOT, how do you feel?</td>
<td>Eckerson and Hammond (2011) show that bar charts are the most preferred way to present information, followed by line charts (3.1) and other, more complex graph types such as waterfall, tachometer, spider charts, etc. (3.2).</td>
</tr>
<tr>
<td>4</td>
<td>High contrast</td>
<td>4.0 If high-contrast presentation is used on your device, how do you feel? If it is NOT included on your device, how do you feel?</td>
<td>High-contrast presentation and aesthetics can improve analytical performance (Salimun et al. 2010).</td>
</tr>
</tbody>
</table>

**Dialog control**

<table>
<thead>
<tr>
<th>No</th>
<th>Software component</th>
<th>Functional and dysfunctional form of MSS user satisfaction</th>
<th>Explanations and references from our literature research</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Navigation philosophy</td>
<td>5.1 If the navigation on your device is rather predefined, how do you feel? If predefined navigation is NOT included on your device, how do you feel?</td>
<td>Different users will prefer different types of navigation (Walstrom and Wilson 1997). We examine a predefined page-by-page navigation (5.1) and an interactive navigation with individual filters, drills, sorting, etc. (5.2).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.2 If the navigation on your device is interactive, how do you feel? If interactive navigation is NOT included on your device, how do you feel?</td>
<td>Following Gebauer and Shaw (2004), we investigate the number of clicks that affects user satisfaction.</td>
</tr>
<tr>
<td>6</td>
<td>Number of clicks</td>
<td>6.0 If the application depth is rather flat (&lt; 3 clicks), how do you feel?</td>
<td>We differentiate between physical interactions such as navigation by wipe function (7.1), fingertip (7.2), and voice (7.3). Adaptive interfaces could be incorporated using an automated mechanism (7.4). For example, the interface could minimize or blend out</td>
</tr>
<tr>
<td>7</td>
<td>Navigation features</td>
<td>7.1 If navigation is supported by a wipe function, how do you feel? If NOT, how do you feel?</td>
<td>Following Gebauer and Shaw (2004), we investigate the number of clicks that affects user satisfaction.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.2 If fingertip navigation is available, how do you feel? If NOT, how do you feel?</td>
<td>Following Gebauer and Shaw (2004), we investigate the number of clicks that affects user satisfaction.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.3 If voice can be used for navigation, how do you feel? If NOT, how do you feel?</td>
<td>Following Gebauer and Shaw (2004), we investigate the number of clicks that affects user satisfaction.</td>
</tr>
</tbody>
</table>

**Table 1. Kano questionnaire regarding software components for managers’ mobile devices**

**Figure 2. Kano model for MSS interface design**
### Validation

**Workshop with Expert Focus Group**

To answer the Kano questions (Table 2), we worked with an *expert focus group*. This format provides direct suggestions and immediate feedback in a personal atmosphere (Österle and Otto 2010). Our focus group consisted of 34 participants from 23 companies. Table 2 summarizes their characteristics. The participants belong to a working group of executives (Level 1) and Level 2 managers who have regularly met three times a year since 2006 to discuss trends in corporate management and MSS support. The
focus group is balanced between executives, directors of accounting or BI departments, and divisional managers. Regarding their working style (Figure 1), this group consists of 20 analyst- and 14 consumer-type managers. For the MSS use case, we assumed a situation in which a manager analyzes information alone in a mobile online MSS access mode (Figure 1). Focus group meetings are hosted by the “Corporate Management System” Competence Center at the University of St.Gallen (http://uss.iwi.unisg.ch).

Table 2. Sample characteristics

<table>
<thead>
<tr>
<th>Position</th>
<th>No.</th>
<th>%</th>
<th>Sector</th>
<th>No.</th>
<th>%</th>
<th>Market capitalization [USD bn]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executives (L1)</td>
<td>14</td>
<td>41</td>
<td>Industrial</td>
<td>15</td>
<td>44</td>
<td>≤30</td>
</tr>
<tr>
<td>Director accounting (L2)</td>
<td>7</td>
<td>21</td>
<td>Financial Services</td>
<td>7</td>
<td>21</td>
<td>30-90</td>
</tr>
<tr>
<td>Director BI department (L2)</td>
<td>10</td>
<td>29</td>
<td>Other Services</td>
<td>12</td>
<td>35</td>
<td>90-120</td>
</tr>
<tr>
<td>Divisional managers (L2)</td>
<td>3</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td>&gt;120</td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
<td>100</td>
<td>Total</td>
<td>34</td>
<td>100</td>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th>No.</th>
<th>%</th>
<th>Working style</th>
<th>No.</th>
<th>%</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤40</td>
<td>8</td>
<td>24</td>
<td>Analyst-type</td>
<td>20</td>
<td>59</td>
<td>Female</td>
</tr>
<tr>
<td>40-45</td>
<td>10</td>
<td>29</td>
<td>Consumer-type</td>
<td>14</td>
<td>41</td>
<td>Male</td>
</tr>
<tr>
<td>46-50</td>
<td>4</td>
<td>12</td>
<td>Sum</td>
<td>34</td>
<td>100</td>
<td>Total</td>
</tr>
<tr>
<td>&gt;50</td>
<td>12</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>34</td>
<td>100</td>
<td></td>
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</table>

Data were obtained in a three-hour moderated workshop in November 2011. The workshop began with an introduction by two facilitators. To provide common ground, participants were given 60 minutes to try out the following end-user devices: Apple iPhone 3GS and RIM Blackberry Bold (smartphone), Apple iPad (tablet), and Lenovo X220t (notebook). Then, the facilitators presented the user interface software components implemented in an MSS called the “Corporate Navigator” (Marx et al. 2011) for another 60 minutes. Finally, participants had 60 minutes to fill out the Kano questionnaire (Table 1). All participants voted using the Kano format (Figure 2) and we calculated percentages for the responses (Table 4).

To determine the coincidence and stability of our findings (reliability), we calculated Cronbach’s alpha (Cronbach 1951) for all software components (SC 1.1–SC 12.3) on smartphones, tablets, and notebooks, assuming that a value of 0.7 or above indicates a high degree of reliability. With alpha values of over 0.9 for both Analyst and Consumer managers for all devices, our results are highly reliable (specifically: Cronbach’s alpha for Analyst managers: 0.94 (notebooks), 0.94 (smartphones), 0.95 (tablets); for Consumer managers: 0.94 (notebooks), 0.91 (smartphones), and 0.96 (tablets)).

Validity indicates whether the questionnaire examines what it is intended to. Our questionnaire has a basis in cognitive fit theory and involved experienced managers (Table 2) in the Kano procedure. Furthermore, we pre-tested the questionnaire with two managers. Based on the findings, we made some changes regarding the flow of the questions. Finally, the structure of the software components in the questionnaire is based on a well-known reference: Warmouth and Yen (1992). Therefore, even though the Kano method has not been applied in the (MSS) domain before, the questionnaire we used should have met the necessary standard of validity.

Results

Table 3 summarizes our findings by listing the share of responses for each software component in each Kano category. The category with the highest share of responses is shaded in gray. Most attractive (A), must-be (M), one dimensional (O), indifferent (I), and reverse (R) attributes are highlighted in yellow, green, gray, red, gray, and blue.

Information presentation

Analyst and Consumer managers consider exception reporting (SC1) a must-have software component for smartphones. On tablets, Consumer managers evaluate exception reporting to be attractive. Managers are
indifferent regarding their MSS entry point with symbols that lead to single reports. However, this type of MSS entry is a one-dimensional component for Analyst managers' smartphones. Furthermore, graphical presentation (SC2) is a must-have component for all end-user devices, Analyst and Consumer managers.

Concerning graph type (SC3), both Analyst and Consumer managers argue against complex charts (e.g., spider or waterfall diagrams) on smartphones (reverse software component: 47.06%, 35.71%). But the larger the device becomes, the more managers ask for more complex charts. In fact, Consumer managers rate these types of charts as attractive on tablets. Analyst managers are indifferent to display contrast (SC4) on all devices. Consumer managers, on the other hand, consider this attribute a must-have component on all devices: smartphones (42.88%), tablets (35.71%), and notebooks (57.14%).

**Dialog control**

Analyst managers consider both predefined and interactive navigation to be similarly important (SC5). Consumer managers are attracted by interactive navigation on smartphones (30.77%) and tablets (23.08%). On notebooks, predefined navigation is an attribute that lowers satisfaction. Consumer managers may be influenced by years of interactive navigation. Both Analyst and Consumer managers rate “less than three clicks (SC6)” as a must-have component on smartphones and as an attractive one on tablets. Regarding notebooks, the responses are diverse: Analyst managers are indifferent regarding the number of clicks, while most Consumer managers consider “three-click” navigation an attractive component.

Concerning navigation features (SC7) on smartphones, Analyst managers evaluate wipe navigation (52.63%) and fingertip navigation (36.84%) as “the more, the better” and adaptive behavior as attractive (47.06%). Consumer managers consider the latter a must-have. Furthermore, wipe and voice navigation and adaptive behavior on smartphones are rather attractive components for them. Although Analyst managers generally view them with indifference, these components still have a high impact on dissatisfaction, as the must-have and one-dimensional ratings show. For notebooks, Analyst managers are indifferent toward all of the navigation components. Remarkably, Consumer managers do not expect any of these components to be included, but they consider adaptive behavior as an attractive component on smartphones (46.15%), tablets (38.46%), and notebooks (38.46%). Regarding drillable charts, Consumer managers do not expect but are very satisfied by “do-more” functions (SC 8.1) and sliders (SC8.2) on smartphones (57.14%) and tablets (42.86%). Moreover, on notebooks “do-more” functions are a must-have software component (42.86%). Analysts are indifferent to sliders on any device. However, they request “do-more” functions on tablets (must-have: 33.33%) and classify them as a one-dimensional component of notebooks (36.84%).

**Information analyses and processing**

Analyst managers expect ad-hoc analysis queries (SC9) on notebooks as “the more, the better” (52.63%). Consumer managers dislike these functions on smartphones (42.86%), but rate them attractive on tablets (42.86%) and notebooks (28.57%). Analyst managers are indifferent towards communication and collaboration components (SC10.1-10.5). They consider e-mailing a must-have software component only on notebooks, and evaluate shared workspaces and groupwork computing on notebooks as a one-dimensional attribute. In contrast, Consumer managers consider instant messaging (35.71%) and voice conferencing (35.71%) as must-have components on smartphones. On tablets they rate, video calling/conferencing, and a shared workspace as attractive components. On notebooks, conferencing is a must-have.

In terms of information retrieval (SC 11), Consumer managers rate business apps (42.98%), convenience apps (35.71%), and the browsing function (35.71%) as attractive components on smartphones. Analyst managers, in turn, rate these components as one-dimensional on smartphones (42.11%) and tablets (55.56%; 38.89%). For Consumer managers, browsing and business apps are must-have software components on their notebooks and tablets. Finally, regarding additional components (SC12), Analyst managers consider self-organizers on smartphones as a must-have (42.11%) and rate both self-organizers and office applications as “the more, the better” on tablets (44.44%) and notebooks (47.37%, 52.63%). Consumer managers are unwilling to relinquish self-organizers on smartphones and notebooks. Surprisingly, on tablets this software component is even an attractive one for them (30.77%). On tablets, Analyst managers rate office applications as one-dimensional (44.44%), while for Consumer managers, this component is a must-have. On smartphones, Consumer managers are indifferent attitude towards office applications (57.14%), so they will not consider working on office documents on their smartphones by themselves.
### Mayer / Kano model and user-interface software components

#### Information presentation

<table>
<thead>
<tr>
<th>MS S Entry</th>
<th>Smartphone</th>
<th>Tablet</th>
<th>Notebook</th>
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<tbody>
<tr>
<td>SC 1.1</td>
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<tr>
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<tr>
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#### Dialog control

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<td>SC 7.4</td>
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<td>36.84</td>
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#### Information analysis and processing

<table>
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<tr>
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<td>SC 10.5 Shared workspace</td>
<td>21.05</td>
<td>26.32</td>
<td>36.84</td>
</tr>
</tbody>
</table>

### Table 5: Kano classification table for MS S software components

#### Consumer

| SC 11.1 Browser function     | 21.05      | 26.32  | 36.84    |
| SC 11.2 Business applications| 21.05      | 26.32  | 36.84    |
| SC 11.3 Creative tasks       | 21.05      | 26.32  | 36.84    |

#### Additional functionality

| SC 12.1 Self-regulating functions | 21.05   | 26.32  | 36.84    |
| SC 12.2 Office applications    | 21.05   | 26.32  | 36.84    |
| SC 12.3 Creativity tasks       | 21.05   | 26.32  | 36.84    |
Synthesis

To derive the most satisfying software components for managers’ mobile workplaces, we calculated the Kano customer satisfaction coefficient (Matzler and Hinterhuber 1998). This value expresses the extent of satisfaction (EoS) – in other words, how strongly the presence of a software component will satisfy a manager on a scale from 0.00 (no impact on satisfaction) to 1.00 (strong impact). For the sake of simplicity, we eliminated attributes for which the EoS score was lower than 0.5. Figure 3 summarizes the results.

(1) Extent of Satisfaction (EoS): \[
\frac{A+O}{A+O+M+I}
\]

![Figure 3. Top satisfying MSS software components (just attributes mentioned with an EoS score equal/higher 0.5)](image)

Based on the findings from Figure 3, we arrive at five design guidelines for mobile MSS. To expand our synthesis and demonstrate utility of our approach, our findings were discussed and applied from January to April 2012 at an automotive supplier (market capitalization: USD 32 bn.; about 150,000 employees). Interviews with the CIO, an Analyst and a Consumer manager revealed MSS trends at the company. In one-hour interviews, participants were asked about their views on their mobile MSS workplace. To avoid circular argumentation, no members of the expert focus group took part in this evaluation interviews.
Managing Hyperconnected Information Retrieval

Analyst managers rate the browsing function, business and convenience apps as one-dimensional. We refer to this mobile MSS area which covers the permanent, ubiquitous flow of information as hyper-connected information retrieval. As Figure 3 shows, EoS values are highest here for tablets (0.61; 0.50; 0.50) and smartphones (0.53; 0.58; 0.53). Analyst managers are satisfied by using business apps on notebooks as well (0.53). Hyperconnectedness is especially important for Analyst managers, but business apps on smartphones and tablets (0.54; 0.50) and convenience apps on smartphones (0.50) satisfy Consumer managers as well. Analyst managers currently do not expect these components, but disproportionately appreciate them when they are included. Remarkably, even Consumer managers are interested in being part of the new hyperconnected information mode.

Hyperconnectedness describes a new “always-online” manager generation in which individuals are permanently connected, causing the distinction between work and free time to vanish. The managers we interviewed stated that they constantly access, generate, and disseminate information that keeps them up to date with both the status of their company and external news. Tablets are best equipped for the information consumption, exception reports, and browsing this will entail. Compared to smartphones, tablets offer more complex types of graphs and complex e-mailing, i.e., they allow users to open office attachments, edit them, and send them back. For mobile workplaces, business apps should provide internal company updates in real time, as well as external information such as flight and train schedules or the latest business news. Convenience apps, in turn, should answer questions like “What is the weather like at my next destination?” “Where is the next taxi stand?” or “What is the best steakhouse in town?” To complement these push functions, Analyst managers want browsing as a way to pull information and fulfill their extensive information needs.

Setting Up Context-Aware Computing

Managers can hardly disconnect from the flow of information, thus, Analyst managers evaluate the adaptive behavior of mobile MSS on smartphones (0.69) and tablets (0.59) as their most satisfaction-enhancing software component. They understand the implementation difficulties and, thus, rate this quality as an attractive one.

Besides the exception reporting common today, context-aware computing should make it possible to reflect a manager’s MSS use situation and determine the flow of information accordingly. For example, if a manager is in the office, the flow of information might be unrestricted. If she/he is driving to visit a plant on the countryside or a customer, the flow could be filtered to include only context-relevant information to prevent overwhelming the recipient. If managers are at home, only top news with tremendous business impact should be reported. This procedure will ensure that mobile MSS is not a permanent distraction. As GPS software becomes standard on mobile devices, a mixture of capabilities will provide the right information for the current use situation. Such a MSS software component will give managers room to stay hyperconnected without suffering information burnout.

Replacing Keyboard and Mouse with Natural Dialog Control

Although Consumer managers do not expect the wipe function for dialog control on smartphones, it is currently the most satisfying component for them (0.77). Analyst managers even rate the wipe function on smartphones as relatively satisfying (0.63) and take a one-dimensional – “the more, the better” – view of this feature. For Consumer managers, the wipe function on notebooks earns a fairly good rating of 0.55 and on tablets a rating of 0.50. In addition, sliders on smartphones (0.73) satisfy the dialog control needs of Consumer managers to a greater extent. Because sliders are rated as an attractive component, they are not expected and can be replaced by traditional pull-down menus.

Consumer managers are satisfied by “less than three clicks” navigation on notebooks (0.64) and tablets (0.50) and with fingertip navigation on notebooks instead of keyboard and mouse control (0.50). Even Analyst managers appreciate “less than three clicks” on the smartphone (must-have component: 0.53). High-contrast presentation on the tablet completes their list of satisfying components (0.50). Thus, another guideline for mobile MSS is to provide natural dialog controls with IS software components such as wipes, sliders, fingertip navigation, and other gestures that will become standard in mobile MSS computing. This holds true for both types of managers, but especially for Consumer managers. Although voice
interaction is the most natural interaction mode, we did not identify it as a trend despite developments in the consumer market and literature (Zhou et al. 2012). However, this technology is just emerging, and many people are still incapable of imaging its capabilities for business use.

Implementing Machine Learning for Simulation and Recommendation Engines

A next step toward context-aware computing and natural IS dialog is to support “do-more” functions combined with an interactive, context-sensitive navigation for Consumer managers on smartphones (0.62; 0.60) and tablets (0.50; 0.57). These capabilities should be complemented by ad-hoc analyses on tablets (0.60) and, for Analyst managers, on notebooks (0.53). We term this MSS component “machine learning.” It will no longer suffice for the mobile workplace to list analysis outcomes in predefined graphs. Analyst managers want to receive the information and feed it into visualization tools to see the findings from different perspectives and launch their own simulations. In the future, it will be necessary for MSS on notebooks and tablets to run even difficult scenarios, large data sets through complex models with conditional variables, and produce highly visual simulations. This proliferation of options will result in MSS that managers actually experience instead of simply viewing. As such models generate results for Analyst managers to evaluate, they will refine themselves to become more intelligent.

In addition, routine activities need to be automated, freeing up managers to perform non-routine work. MSS software components should call managers’ attention to information beyond what they already use and request that might interest them. Recommendation engines will therefore become an interesting software component. To successfully perform this task, MSS must analyze what managers are currently looking for and then use this information to optimize recommendations for the requesting manager.

Leveraging Embedded Collaboration, Especially for Wicked Problems

Under the heading “embedded collaboration,” we subsume e-mailing, shared workspaces, and self-organizing functions on tablets for Consumer managers (0.62; 0.54; 0.54), the integration of office applications on notebooks and tablets (0.53; 0.50), and self-organizing functions (0.53; 0.50) for Analyst managers. In the past, communication functions were separate from MSS. Today, ease-of-use and social collaboration is key, especially to jointly solve difficult problems. The managers we interviewed would like this separation to disappear. In particular, collaboration should become an integral part of MSS. Active managers’ access information and add value by, e.g. interpreting numbers, commenting on exceptions, and sharing their input with others. More passive managers, in turn, consume this information, along with all the enhancements. Video calling/conferencing with easy-to-use, high resolution (HD) interfaces (0.54) is one improvement that enhances such collaboration. Tablets are well suited for this functionality. Furthermore, synchronicity in distributed work will grow, leading to instant messaging and functions that make it easy to track what people are doing and when they are available.

Outlook and Future Research

By performing a multidisciplinary literature review and applying the Kano model, we arrive at five guidelines for shaping managers’ mobile workplaces. To arrive at these guidelines, we clustered software components from a managers’ perspective and then identified those that most enhance satisfaction.

Our research reveals avenues for future research. Publications from practitioners should expand our literature review to examine additional MSS software components. A second limitation of our work is the number of MSS use factors, which we restricted to ensure a manageable number of use situations. In particular, managers’ working styles should be captured in greater detail in future. Gender, age, temperament, self-efficacy, level of expertise, prior IS experience, and past device-usage pattern (Table 2) might be important here, as well as cultural factors. Furthermore, the issue of end-user device selection was examined in a schematic way only, and future MSS research should consider that distinct classes of devices are vanishing. Moreover, functional and non-functional requirements may change more rapidly.

The Kano model is useful in matching managers’ user preferences with IS design and resolving trade-offs between different software components. However, a better basis is needed to transfer this method to HCI research. Our interviews with the expert focus group did not constitute a “real world” context. Thus, a next design cycle with a broader research method should follow. However, the method used here should help HCI researchers to seriously examine IS design, even for domains other than MSS.
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