Situational Management Support Systems

Accommodating the Growing Range of Working Styles, Use Cases, and Access Modes

This article proposes a configuration model for tailoring management support systems (MSS) to managers' growing range of working styles, MSS use cases, and MSS access modes. Clustering their possible characteristics yields 36 use situations. Configuring MSS to these use situations, we apply the selection of end-user devices and MSS user-interface designs.

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1 Introduction

Managers and their information systems (IS) have been a constant topic of interest to researchers over the last five decades (Ackoff 1967; Mintzberg 1972; Rockart and Treacy 1989; Elam and Leidner 1995; Wixom and Watson 2010). Both the terms management support systems (MSS; Clark et al. 2007, p. 579) and decision support systems (DSS; Arnott and Pervan 2008, p. 657) 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, pp. 122–124), we refer to our object of study as MSS. This term was first used by Scott Morton (1967) and covers MIS, DSS, EIS, and, more recently, knowledge management systems (KMS) and business intelligence (BI) systems for managers (Carlsson et al. 2009, pp. 1–2; Kemper et al. 2006, pp. 1–2; Watson 2009, pp. 488–490).

The non-functional perspective on MSS design currently holds two interesting aspects. First, digital natives increasingly populate organizations' management, along with digital immigrants. The latter learned to engage with IS and developed into MSS users over the years (Vodanovich et al. 2010, p. 713). These new-generation managers more naturally accept MSS, but also have higher expectations about how these systems should accommodate their user preferences. Second, technical progress has been made in recent years, so that even senior managers should be able to operate MSS themselves. Thus, MSS use factors are gaining importance as MSS design broadens its scope beyond deployment to include managers' use and impact perspectives as well (Marchand and Peppard 2008, pp. 8–10).

Following Vodanovich et al. (2010, p. 713), who state that the way digital natives use IS will lead to a fundamental shift in IS research, we focus on the non-functional perspective on MSS design. New-generation managers in particular question MSS without configuration mechanisms to accommodate their growing range of use situations, which we define as distinct classes of user-group preferences (Wixom and Watson 2010, p. 25; from a conceptual perspective, Winter 2011).

IS use is not mandatory for managers. In the worst case, they can exempt themselves from organizational dictates and refuse to use MSS both because of their position within the firm per se and because they typically have support staff, such as secretaries, personal assistants, etc. (Young and Watson 1995, pp. 154–155; Ikart 2005, p. 78; Majid et al. 2012, p. 14). They handle managers' MSS access when information is needed and help them with MSS printouts. Therefore, it is especially important for the MSS domain to make these systems attractive to managers by accommodating their individual user preferences. At the same time, extreme individualization that meets all needs does not make sense from an efficiency perspective (ISO/IEC 9126-1 2010).

The objective of this article is to lay out a comprehensive configuration model that reveals managers' different MSS use situations and proposes levers for tailoring (conceptual) MSS design to them. The purpose is twofold. First, the model provides a structure for situational MSS design with a taxonomy of use factors and combinations of their characteristics. Second, it covers levers to configure (conceptual) MSS design to produce the least general solution for demonstrated user-group preferences.

We follow design science research (DSR) in IS (Hevner et al. 2004). Although we therefore focus on IS use and its requirements, the findings should be relevant for software engineers as well.[1] Various processes have been proposed for developing artifacts under the design science paradigm (March and Smith 1995; Peffers et al. 2006). Emphasizing "build" and "evaluate" activities, we apply Peffers et al.'s (2006) process model. First, we motivate this article by identifying current gaps in managers' acceptance of MSS and suggest a configuration model to tailor (conceptual) MSS design more closely to their user preferences (Sect. 1). After laying foundations (Sect. 2), we perform a literature review to identify three factors for clustering managers' growing range of user preferences. Combining their characteristics yields 36 use situations (Sect. 3.1). Second, we propose the selection of end-user devices (Sect. 3.2) and, third, their appropriate user-interface design (Sect. 3.3) as levers for MSS configuration. By applying the configuration model, we generate situated MSS variants (Sect. 4). Finally, we use results from a workshop to evaluate our proposal (Sect. 5). The article concludes with a summary and discussion of future research (Sect. 6).

2 Related Work

2.1 User Preferences in MSS Research and Design Theories

According to ISO 9241-110 (2008, p. 6), interactive MSS are a combination of software and hardware components that receive input from managers and communicate output to support them in performing their management tasks. User interfaces are "[…] what users see and work with to use a product" (Hackos and Redish 1998, p. 1). End-user devices, in turn, are the physical part of IS handled by the user (Laudon and Laudon 2010, pp. 631–639).

User preferences describe differences in the way human beings want to use IS. They result in different requirements concerning how IS should provide functions or services. User preferences have been a topic of MSS research since the 1970s. Our prior research (Mayer et al. 2011, pp. 292) outlines that, as early as 1979, Zmud (1979, p. 975) echoes several authors by claiming that "individual differences do exert a major force in determining MSS success". However, a few years later, Huber (1983) took the wind out of the sails of Zmud's approach for many years to come. He claimed that accommodating user preferences requires IS designers to consider too many characteristics, and that MSS might be completely configurable by users in the future anyway.

The last 20 years invalidate Huber's line of argument. User acceptance has been the object of research and theories, including the technology acceptance model (TAM) by Davis (1989) and the IS success model (DeLone and McLean 2003). Although several points of criticism exist, i.e., TAM is losing relevance in an increasingly changing world leveraging "modern" IS,[2] these explanatory theories (Gregor and Jones 2007) help to understand and predict IS phenomena, even if they do not directly support the design of innovative artifacts. To overcome these drawbacks, we examine managers' MSS use situations (Sect. 2.2).

However, TAM and IS success models show that user characteristics and their preferences play a predominant role in IS success. User preferences are particularly important for MSS design, where strong idiosyncrasies must often be considered. The higher managers are positioned within the organization, the more likely they have an extensive education and multifaceted work experience that become a basis for developing and exhibiting a highly individual IS attitude (Volonino et al. 1995, p. 107). In the light of such idiosyncrasies, a one-size-fits-all concept that designs MSS for a "typical" user is no longer sufficient. At the same time, MSS design that would meet the requirements of all potential managers is untenable from an efficiency perspective (Sect. 1). By adapting situational method engineering (Brinkkemper 1996), adaptive reference modeling (Becker et al. 2007), design for artifact mutability (Gregor and Jones 2007), or configuration of standard software (IEEE 2005; ISO 2003), MSS designers could achieve a balance by segmenting different classes of requirements.[3]

Requirements are prerequisites, conditions, or capabilities needed by the users of a software system (IEEE 1990, p. 62). Design principles, in contrast, go beyond requirements to serve as predefined actions for bringing MSS to life. We use situational MSS construction to generate possible solutions that grant a high level of MSS utility by applying configuration mechanisms. Configuration mechanisms are mechanisms for incorporating all potential variants into the generic artifact (Becker et al. 2007, pp. 33–35). Because the number of MSS use situations is manageable, we apply configuration mechanisms instead of composition. Use situations generalize "similar" user-group preferences in the meaning of classes. The resulting design objective is then to provide a situated solution for each use situation.

2.2 State of the Art

The following citations extend our prior work (Mayer et al. 2011, pp. 293–294) by adding computer science (CS), especially software engineering sources, to incorporate more technology-oriented con-

[1] Whereas Computer Science (CS) is more focused on information and communication technologies itself (Avison and Elliot 2006, p. 6–8), IS research transforms business requirements into (conceptual) IS design (WKWI 2012). Thus, IS research moves away from a focus on technology to consider the interplay of people, task, and technology. Those working in CS, especially software engineers, then transform these IS designs into efficient software solutions.

[2] Chuttur (2009) claims that the practical value of TAM and its explanations are limited. Determinants such as age, level of education, or setting also significantly impact IS usage. Furthermore, after a series of modifications, a commonly accepted TAM no longer exists (Benbasat and Barki 2007, p. 2011). In other words: "The […] attempts […] to expand TAM in order to adapt it to the constantly changing IT environments has led to a state of theoretical chaos and confusion […]."

[3] Situational design approaches were adopted from organization theory in the early 1990s (Kieser and Kubicek 1992). The theory of cognitive fit states that decision making is efficient and effective when the presentation of a problem is in line with an individual's approach to problem-solving (Vessey 1991).

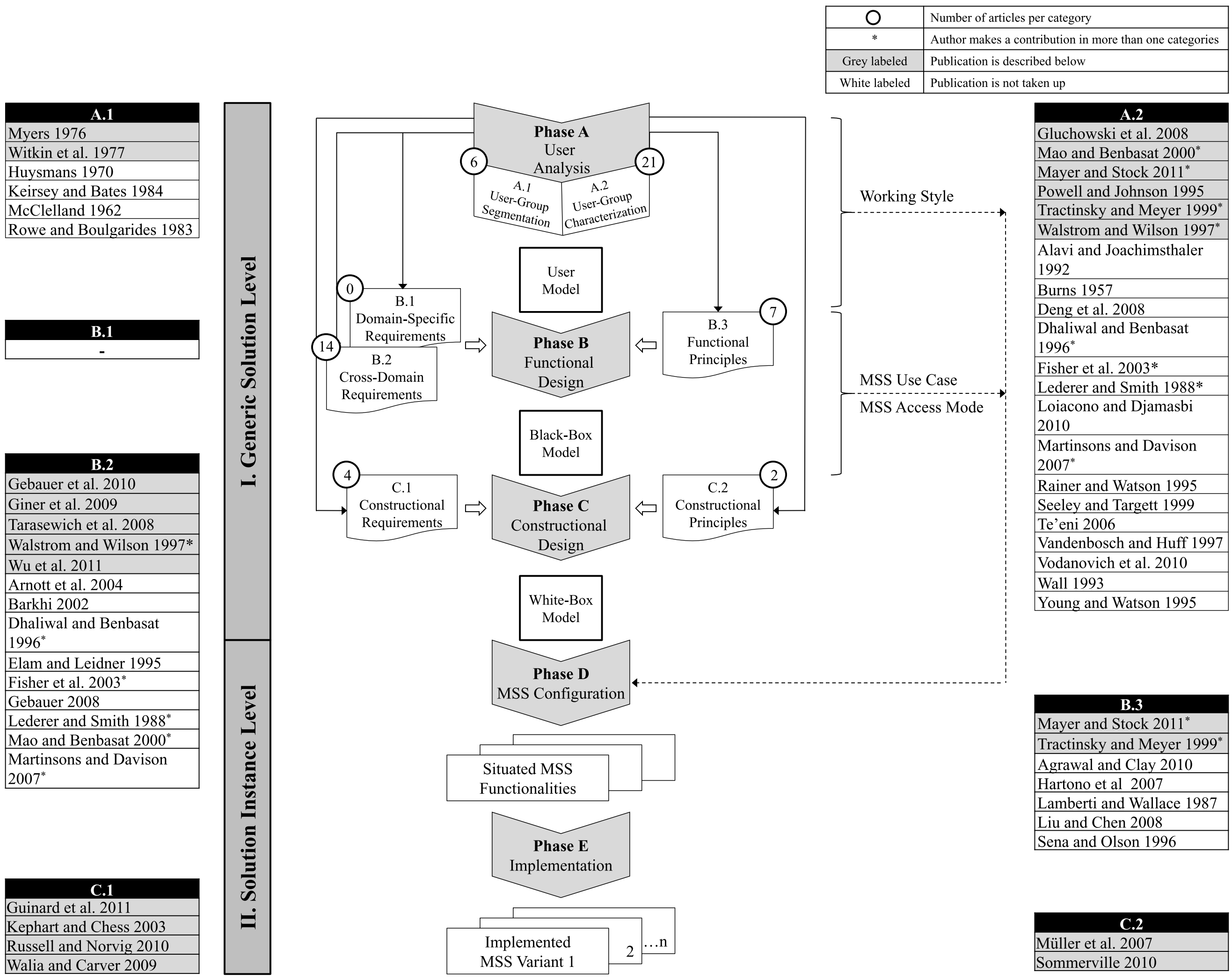

Fig. 1 Publications examining user-group characteristics in MSS design (Expanded illustration based on Mayer et al. 2011, p. 296)

cepts (Avison and Elliot 2006, pp. 6 ff.; Sommerville 2010, p. 7).

Leveraging research on human-computer interaction (HCI, Zhang et al. 2002), we begin our literature systematization with a user model (**Fig. 1**). It segments user groups (A.1) and differentiates user-group characteristics that have an influence on how managers use MSS (A.2). We continue with enterprise engineering (EE; Dietz 2007), which separates the MSS design process into two stages. The black-box model only describes the users' perspective on MSS, covering their functional requirements and functional principles (B.3). The white-box model considers the constraints on MSS design from the engineering perspective in the form of constructional requirements (C.1) and constructional principles (C.2). Several findings from CS references, especially software engineering, contribute to the MSS constructional perspective. We use requirements engineering (RE) to structure the functional requirements. In so doing, we distinguish between domain-specific requirements (B.1), which cover the purpose of MSS, and cross-domain requirements (B.2), which address more formal aspects of MSS (Sommerville 2010). Finally, we distinguish between a generic solution level and a solution instance level (Lee et al. 2011). The former covers abstract domains of MSS design. To be applied in practice, they must be instantiated to produce situated MSS functionalities that, in turn, must be implemented (MSS variants 1 – n). Phases C and D are specified in Sects. 3.2 and 3.3.

In line with Webster and Watson's (2002) general approach, we focused on leading IS research outlets and selected ten journals based on the catalog provided by the London School of Economics (Willcocks et al. 2008) for our literature review.[4] Furthermore, we expanded our list with proceedings from ICIS and ECIS. To ensure our journal base reflects the computer engineering

[4]It incorporates not only mainstream IS journals, but also social studies of IS. We choose the five top journals from each set, namely: MIS Quarterly, Information Systems Research, Information & Management, Journal of Management Information Systems, and Decision Support Systems as well as European Journal of Information Systems, Information & Organization, Information Systems Journal, Journal of Organizational and End-User Computing, and Journal of Information Technology.

Table 1 Search string of the keyword search

		OR						
AND	IS focus	management support systems (MSS)	management information system (MIS)	decision support system (DSS)	executive information system (EIS)	data warehouse (DW, DWH)	business intelligence (BI)	decision making
	User focus	use	style	pattern	adoption	acceptance		

discipline, we included publications from five journals of systems and software engineering[5] and four CS journals[6] as well. Additionally, our search covered six HCI journals.[7] Using EBSCOhost, Science Direct, and ProQuest, our keyword search (**Table 1**) on titles and abstracts resulted in 469 hits, of which we found 24 to be relevant. A final backward search led to a total of 40 relevant publications.

Figure 1 shows relevant work identified at the generic solution level. Studies may appear more than once if they relate to more than one component of the framework. Publications with the highest impact factors are highlighted in gray and briefly described below.

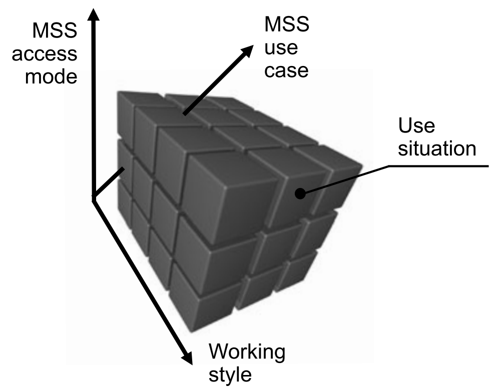

Fig. 2 36 MSS use situations – based on an enumeration of four working styles, three MSS use cases, and three MSS access modes

Phase A – User model: A first group of publications deals with individual cognitive styles and covers techniques for user-group segmentation (A.1). Two 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 details (less analytical). Field-independent people, in turn, pay more attention to details (more analytical).

A second group of publications covers user-group characterization (A.2). These studies either apply the techniques employed in the group above and 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 user groups and their "typical" MSS usage. Another example of the first approach are Mao and Benbasat (2000), who demonstrate that a user's level of expertise has an effect on his or her MSS usage. Tractinsky and Meyer (1999) claim that a MSS user is not only in a receiving role, but also a presenting one. The second approach is from Walstrom and Wilson (1997), who divide managers into three user types: converts, pacesetters, and analyzers. Gluchowski et al. (2008) propose three groups as well: information consumers; analyst users, who want to navigate within delivered information; and specialist users, who look for mathematical, statistical, and economic models. Based on findings from companies listed in the Financial Times "Europe 500" report, Mayer and Stock (2011) identified several areas that most determine C-level managers' acceptance of MSS: the appropriate MSS entry point, the ease of navigating from that point through the MSS, the business orientation of the information provided, and the inclusion of basic analytic functions. Combining different characteristics of the executives participating in the study, the authors arrive at four working styles: analytical power users, opportunistic analysts, all-around basic users, and de facto non-users. These publications show that a number of authors provide methods to differentiate individual cognitive styles (A.1), and even more publications consider characterizations of user groups (A.2) and their associated MSS usage. Thus, we argue that the influence of different user-group preferences must be considered in MSS design. Our configuration model collectively refers to the individual variables constituting managers' user preferences as working styles (**Fig. 1** and later Sect. 3, **Figs. 2** and **3**).

Phase B – Black-box model: MSS literature provides several methods for determining information needs as a starting point for domain-specific requirements (B.1). One example is the Balanced Scorecard (Kaplan and Norton 1996). However, none of these proposals consider connections between user-group preferences and MSS design. Another segment examines implications of

[5]Based on journal rankings of AIS (2010); VHB (2008) and impact factors from http://www.elsevier.com. We found Information and Software Technology, Communication of the ACM, ACM Computing Surveys, Journal of Systems and Software, and the International Journal of Systems Science.

[6]Based on the AIS journal ranking (2010), we selected IEEE Software, Journal of Computer and System Sciences, IEEE Transaction on Computers, and Behaviour & Information Technology.

[7]We found ACM Transactions on Computer-Human Interaction, Human-Computer Interaction, International Journal of Human-Computer Interaction, International Journal of Human-Computer Studies, Computers in Human Behavior, and AIS Transaction on Human-Computer Interaction in the journal rankings of AIS (2010) and VHB (2008).

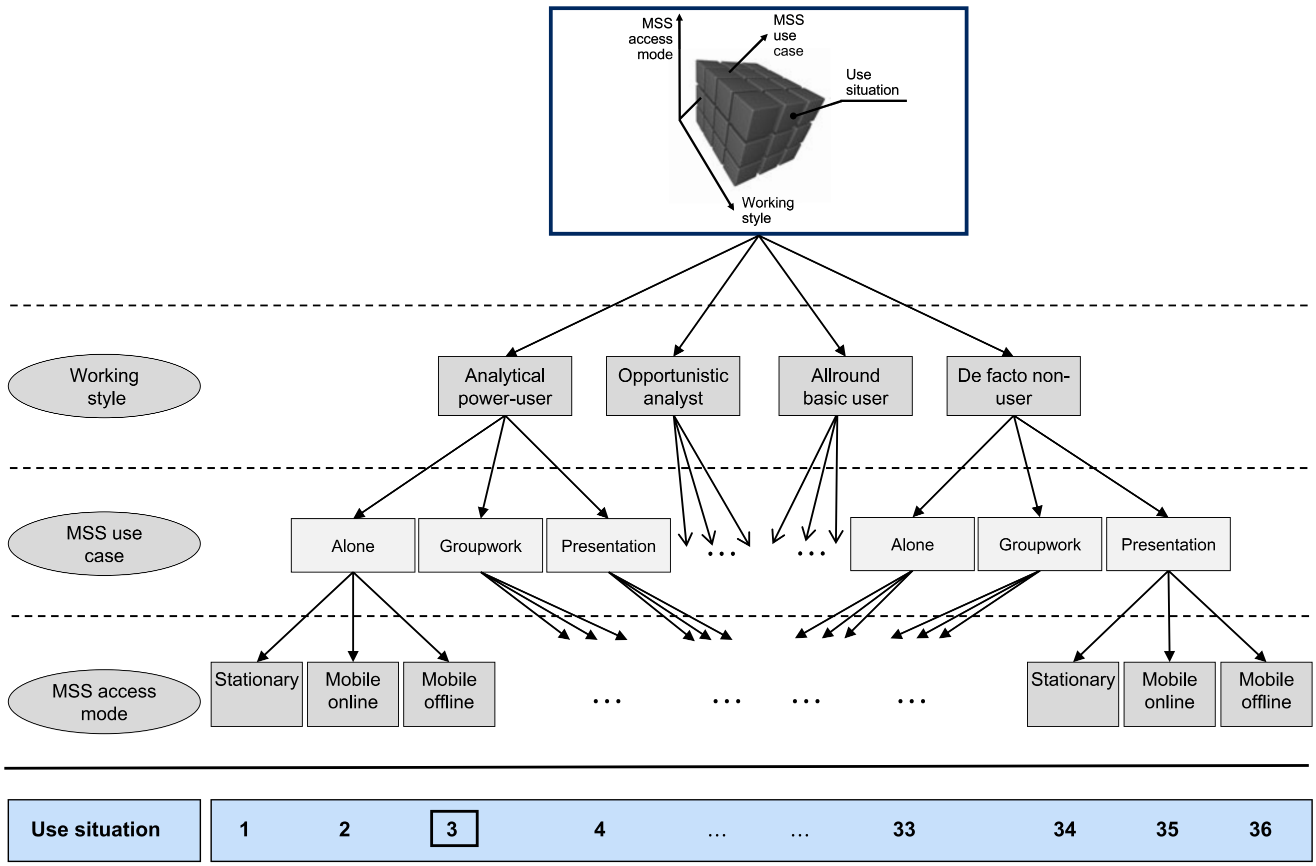

Fig. 3 Decision tree for situational MSS design

user-group preferences on cross-domain (functional) requirements (B.2). Walstrom and Wilson (1997) find that converts use MSS to gain access to predefined reports, key performance indicators, company news, and sources even outside the company. Analyzers, in turn, use the MSS primarily to perform analysis of data that was not previously available. Pacesetters make extensive use of communication capabilities to share information. Most publications focus solely on layouts for desktop PCs (Wu et al. 2011), but MSS designers are already pursuing designs for mobile devices that attract and captivate managers as well (Giner et al. 2009). Gebauer et al. (2010) classify mobile use contexts in terms of the level of distraction, connection quality, and mobility, and state requirements for these situations. Tarasewich et al. (2008) identify several future issues in this area: a changing context, limited user attention, users' occupied hands, high mobility, and IS interaction while in motion.

Tractinsky and Meyer (1999) derive functional principles for MSS design (B.3) based on the tasks of MSS users within the company. If the reports in the MSS are used to aid decision making, the interface should be restricted to 2D bars and figures so as to not distract from the content. Based on their distinction among managers' working styles, Mayer et al. (2011) define cross-functional principles for designing MSS user interfaces. Two findings emerge from these groups of publications (B.1–B.3). First, although research exists on the implications of user-group preferences for functional requirements, its relevance is limited because these studies do not characterize user groups consistently. Unlike the number of articles regarding functional requirements (B.1, B.2), no faceted body of knowledge on functional principles (B.3) is available. To take account of various working situations in which managers use MSS, we incorporate their MSS use cases into our configuration model (**Fig. 1** and later **Figs. 2** and **3**, specific use cases are defined in Sect. 3). Second, the findings show that managers' MSS access influences their usage to a great extent. Therefore, we incorporate their MSS access modes into our configuration model as well (**Fig. 1**, MSS access modes are defined in Sect. 3, **Figs. 2** and **3**).

Phase C – White-box model: In terms of constructional requirements (C.1), Walia and Carver (2009) classify errors that occur during the requirements phase. Guinard et al. (2011) demonstrate that MSS design has to accommodate changing requirements. Autonomic computing – IS that manage themselves in line with predefined objectives (Kephart and Chess 2003, p. 41) – and autonomous computing – artificial intelligence (Russell and Norvig 2010) or self-learning IS – can be techniques for handling this issue. Turning to constructional principles (C.2), dealing with IS architecture approaches, such as service-oriented architecture (Sommerville 2010), is primarily a task for software engineering. Another concern in IS design is the growing importance of data protection (Müller et al. 2007). Although various authors deal with architecture styles, changing IS requirements, or security issues, only some consider the implications of user-group preferences on the constructional requirements or principles.

3 Construction of the Configuration Model

Following the black-box method from mechanical engineering, our configuration model for situational MSS design is expressed in terms of system input and output (Matek et al. 1987). Under the "IS design for use" approach (Sect. 2), our literature review reveals three MSS use factors in terms of system input (Sect. 3.1). The combination of their characteristics determines MSS use situations, or generally applicable classes of user-group preferences for situational MSS design. For the model output, we select end-user devices (Sect. 3.2) and appropriate software components for the user interface of these devices (Sect. 3.3). Both need to be situated using the configuration mechanisms (**Table 2**).[8]

3.1 MSS Use Factors and Enumeration of Use Situations

Variations in terms of how managers prefer to gather, analyze, and process information (user model, **Fig. 1**) were summarized as their working style (Sect. 2.2), the first MSS use factor in our configuration model. We follow Mayer and Stock (2011), as their findings are based on a current survey and they applied a rigorous factor and cluster analysis to arrive at their results. They identify four working styles among C-level managers. Analytical power-users are very frequent users who work extensively and independently with MSS. This user type performs in-depth analysis beyond standard reporting and needs a lot of individualized information, even in granular form. Opportunistic analysts use MSS actively and regularly. They also perform analyses independently, but not necessarily on their own. All-around basic users see less value in being able to perform analyses with MSS themselves. They prefer financial KPIs to operational information and want to access details only as they enter the MSS. Their unwillingness to use MSS makes them indifferent to the starting point within the MSS for launching an analysis. De facto non-users reject MSS. While they want some financial KPIs in exceptional cases, they generally consider more in-depth IS support unnecessary or a task for their support staff.

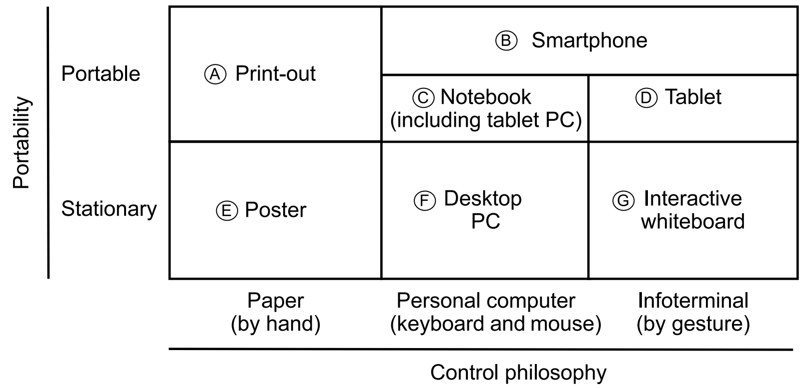

Fig. 4 Classification of end-user devices

Along with managers' working style, we incorporate their MSS use case into our configuration model. Following Walstrom and Wilson (1997), we claim that MSS users are not only in a receiving role, but also act as communicators and presenters. For the sake of simplicity, our MSS configuration model distinguishes three "typical" MSS use cases based on the number of participants: analysis (manager alone: e.g., desk research in the office); group work (one-to-few: manager with colleagues, personal assistants, or other support staff); and presentation (one-to-many: manager in front of an audience, e.g., in a board meeting).

Finally, our research implies that mobile use has become an increasingly important challenge for MSS design (Gebauer et al. 2010, p. 269; Wright 2010, p. 66). To reflect its significance, we incorporate managers' MSS access mode into our configuration model.[9] Accessing information is relatively easy from one's own desk with a fixed (physical) cable, W-LAN, or UMTS connection. We call this MSS access mode stationary. Internet access can be limited to GPRS, UMTS, or public W-LAN "hot-spot" connections with disruptions when managers travel by car or train or spend time in the countryside. We refer to this mode as mobile online, sometimes with disruptions. In other mobile situations – such as in planes, high-security buildings, cars with a driver, or other remote places where no online service is available – access is typically mobile offline.

While managers' working styles should be relatively constant over time, their MSS use case and MSS access mode can change several times a day. The combination of managers' four working styles, three MSS use cases, and three MSS access modes yields 36 possible MSS use situations (**Fig. 2**). A generic MSS design must accommodate all of them.

Referring to **Fig. 1**, our configuration model must first serve as the basis for the solution instance level: MSS variants $1 \ldots n$. The resulting design objective is then to provide one situational solution for each of the 36 use situations by selecting the appropriate end-user devices and user-interface design. The use situations for MSS design are illustrated in **Fig. 3**. As an example, we highlighted an analytical power-user (working style) analyzing data alone (MSS use case) in a mobile offline MSS access mode (= use situation 3).

3.2 End-User Device Selection

Following Gebauer et al. (2010), we propose the selection of end-user devices as a first configuration mechanism in our model. Today, a variety of devices are available (**Fig. 4**) and new products that blur the boundaries of former device classes are constantly entering the hardware market. We include tablet PCs in

[8]To reduce complexity, we assume that requirements stay constant. See Sect. 6 for a proposal on handling change over time with autonomic and autonomous computing.

[9]The MSS access mode and its characteristics – stationary, mobile online, mobile offline – should not follow short-term fads, but stay relatively constant both over time and across individual managers' MSS requirements. Thus, access mode is our third and final MSS use factor determining the MSS use situations (**Fig. 2**). End-user devices, in turn, change more quickly, especially regarding their size and control philosophy. We therefore consider the selection of the latter to be a lever for configuring MSS (Sect. 3.2).

Table 2 Assigning software components for a situational user-interface design accommodating managers' different use situations and end-user device selection

	Description of user-interface components	1		2			3		4		...	...	33	34			35	36		
	End-user device	C	D	C	D	B	**C**	D	A	C	...	...	A	C	E	G	C	A	C	G
	Information presentation																			
1	First orientation by picture, headlines, and teasers with a "read more" function						**X**	X						X		X				X
2	Corporate overview entry with symbols for single reports	X	X	X	X	X				X										
3	Visual analysis tools by 1-3 clicks (filtering, compare, correlate, and incorporate details)					X		X						X						X
4	More than 3 clicks for 2-dimensional number based analysis (MS Excel)			X	X		**X**													
5	More than 5 clicks for n-dimensional analysis (drag & drop for OLAP analysis)	X	X													X			X	
	Dialog control																			
6	Static, predefined display (page-by-page navigation)					X		X						X						
7	Interactive display (filter, drill, calculate, sort, rank)	X	X	X	X		**X**													
8	Navigational breadcrumbs	X	X	X	X		**X**									X				
9	Do more function (expose additional report/graph features)	X	X	X	X	X		X												
10	Sliders to adjust variables	X	X	X	X		**X**	X						X		X				
11	Direct links to predefined analysis (e.g., net sales by product, country, etc.)	X	X					X												
12	Direct links for ad-hoc reporting, non-routine information, and upstream IS	X	X																	
	Analytical functions																			
13	Topic-monitoring (IS scanning reports for selected key topics automatically)	X	X																	
14	Follow comments in a (firm-intern) blog (including a notification when other users add comments)	X	X	X	X		**X**	X	X											
15	Statistic functions (e.g., regressions)						**X**													
16	Semantic search (searches for meaning not only words)	X	X			X	**X**													
17	Ad-hoc analysis	X	X				**X**													

the notebook class, as they have smaller screens (e.g., 12.1-inch), but still retain the key features of a full-sized notebook, such as a tactile keyboard. Second, products such as Apple's iPad and Android 3.0 devices combine a letter-sized screen (9.7 inch, 1024 × 768-pixel resolution or better) and easy-to-use handling to claim a niche between notebooks and smartphones. Such tablets are controlled by gesture via touchscreen.

Since tablets as an end-user device class show that screen size and functionality are no longer necessarily decisive characteristics, we follow Paech and Kerkow (2004) by proposing aspects of usability as the core distinguishing features of end-user devices (**Fig. 4**):[10] Portability defines the ease with which an IS can be transferred from one environment to another and distinguishes whether devices are stationary or portable (IEEE 1990). While the former offer bigger and brighter screens, the latter require smaller screens and lighter hardware, even at the cost of functionality, performance, or external devices, such as CD-ROM or Blu-ray players. The control philosophy is important in terms of how users create and access information (McCracken 2010). Desktop PCs are traditionally controlled by keyboard and a mouse, info terminals by stylus or touch (gesture). Although not an electronic device, paper still plays an important role because it can be easily shared during a conversation and annotated.

Figure 5 schematically summarizes the configuration mechanism of our model. Either one or more end-user devices are selected ("X," left, schema) for each of the 36 possible use situations. Even assuming

[10]We are aware that this (and other) classification schemata will likely be out of date in the predictable future. In fact, some tablets already provide built-in HDMI that allows presentations with pocket projectors. However, we think that this classification is sufficiently current to support our research here.

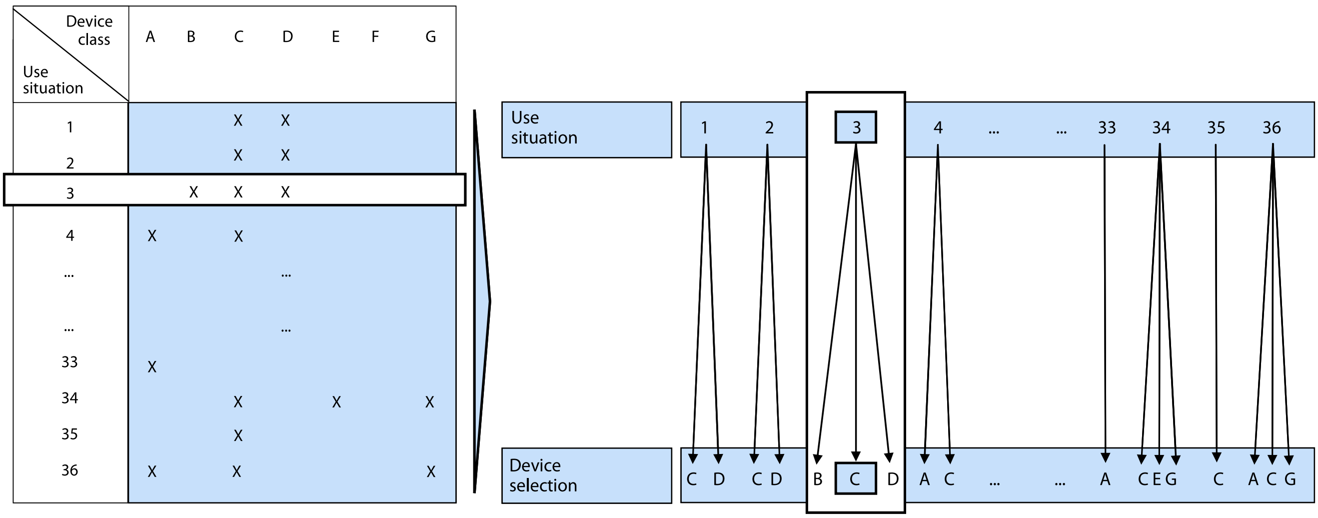

Fig. 5 Selection of end-user devices for the selected use situations (schematic)

company-specific selection, we have to expand our classification scheme by additional 1:n combinations of use situations (right, bottom line) to include managers' end-user device selections. **Figure 5** highlights the analytical power user (working style) as an example of someone who prefers to use a notebook (C) for analyzing data alone (MSS use case) in a mobile offline MSS access mode (use situation 3, **Fig. 3**).

3.3 Software Components and User-Interface Design

Findings from our literature review showed that appropriate user-interfaces, defined as situated combinations of different software components, simplify MSS handling. We therefore propose their design as the second MSS configuration mechanism. Following our literature review, most publications still focus on layouts for (stationary) desktop PCs, but MSS designers are increasingly pursuing designs for mobile devices. In this process, software components have evolved over the last 20 years from simple controls, such as text fields, buttons, menus, and tiny icons, to an easy-to-use palette of components (Tidwell 2005, p. xi).

Eckerson and Hammond (2011) list user-interface software components: drillable charts; the ability to publish to MS Excel, Word, or PDF; role-based views; embedding in a portal; universal filters; alerts and stoplights; personalization; one-click access to metadata; mouse overs; sliders to adjust variables; links to related content; navigational breadcrumbs; bookmarks; and Flash/Silverlight animations. We add unlimited interactive navigation vs. page-by-page navigation, point of IS entry, predefined analysis, ad hoc queries, blending-out of unneeded functions and information, and direct links to upstream IS (Mayer and Mohr 2011; Mayer and Weitzel 2012).

To give these software components a basic structure, we follow Warmouth and Yen (1992) in identifying three dimensions of MSS user interfaces. First, user interfaces have to provide high-quality information presentation. This includes basic design decisions, such as showing information in textual or graphical form and the use of traffic-light coding or intuitive icons. The second dimension is dialog control, which covers MSS navigation elements. The window inside technique, breadcrumbs, tabs, mouse overs, and direct links to upstream IS are such elements (**Fig. 7**). Finally, we choose analytical functions that managers can handle on their own.

Using findings from an expert focus group on the inclusion of software components on different end-user devices (Mayer and Mohr 2011), the three user-interface building blocks have been detailed with 17 software components (**Table 2**). The choice of software components is schematic, with one exception: to illustrate our configuration model, preferred components for use situation 3 ("analyzing data alone in a mobile offline mode") are based on findings from the expert focus group that considered both use situation and choice of end-user device – in our case, a notebook.

4 Demonstration

To demonstrate the utility of our configuration model, we tailored an actual MSS (Marx et al. 2011) as follows.[11] Its generic solution level covers three levels of analysis "A–C" (**Fig. 6**). They are summarized in the corporate overview, which serves as the general IS entry point for standard reporting or for direct navigation to the underlying levels of analysis.

(A) The corporate portfolio (marked as "A") is the most aggregated level of analysis. It offers a graphical overview of financial performance based on three KPIs: reward, risk, and relevance.

(B) The corporate dashboard (marked as "B") is the second level of analysis. It consists of a one-page format with more detailed KPIs structured in five information clusters: financial accounting, management accounting, compliance management, program management, and cash flow and liquidity management.

(C) Finally, the corporate analyses (marked as "C") make deeper analysis possible with ten standard analyses and a flexible pe-

[11] In terms of architecture, our prototype has four MSS layers: (1) information presentation (SAP BO Dashboard); (2) business application (SAP BO Enterprise, SAP ERP Financials); (3) data storage (SAP Business Warehouse); (4) data integration (SAP data services).

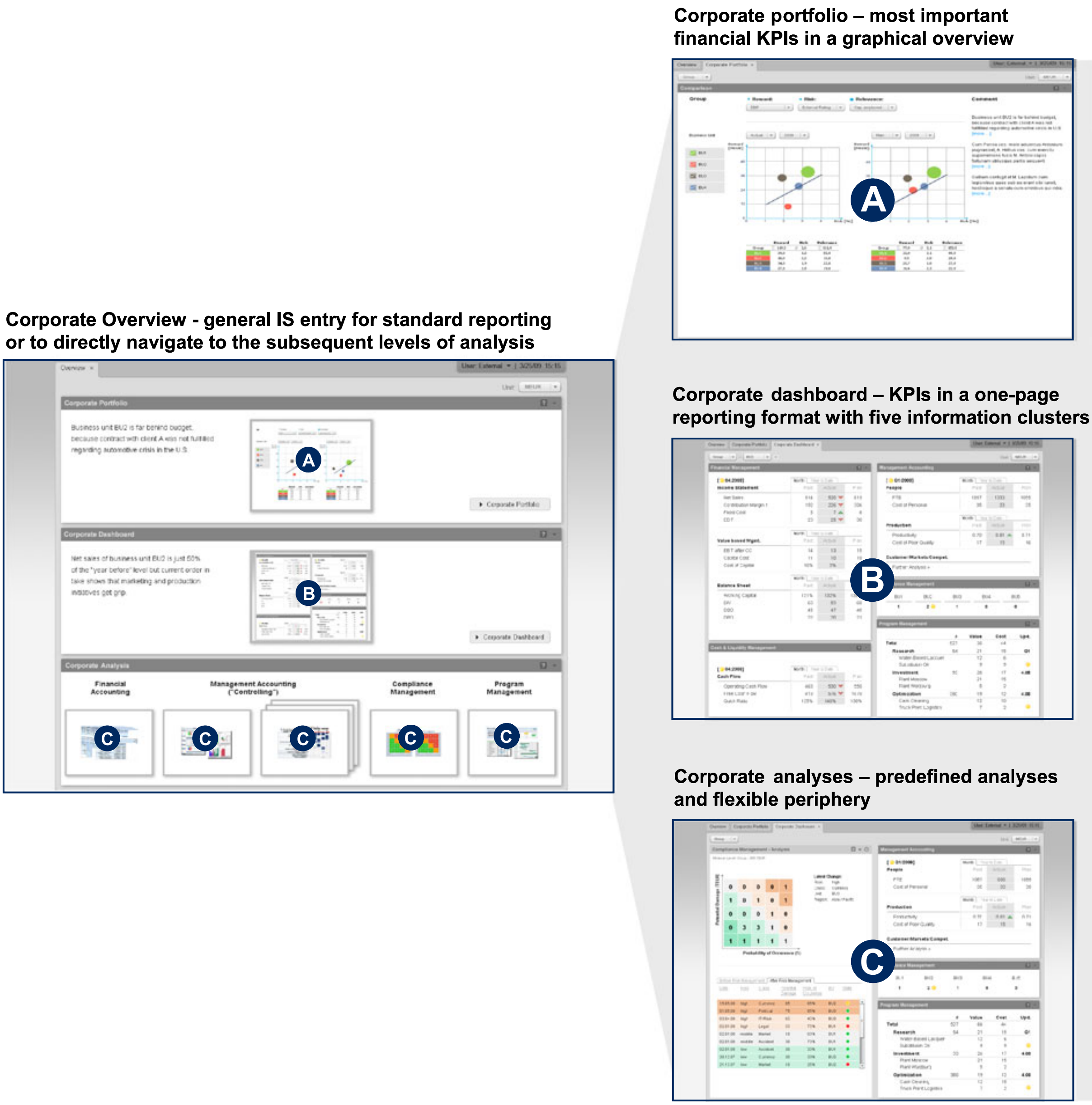

Fig. 6 Corporate Navigator report architecture (Marx et al. 2011, p. 15)

riphery for ad hoc reporting, non-routine information, and links to upstream IS.

Differentiating between the more tech-savvy Analyst MSS users – analytical power users and opportunistic analysts – and lighter Consumer users – all-around basic users and de-facto non-users (**Fig.** 2) – we incorporate situated MSS software components based on our results in **Fig.** 5. Analyst users prefer to enter the MSS on notebooks via an aggregated overview. Therefore, the corporate overview uses graphical icons to represent the most important reports available (**Fig.** 7, left). Thanks to comments provided directly on the KPIs (**Fig.** 7, left) Analyst users can continue with self-service analysis, which increases in depth along with the size of the device. On notebooks or tablet PCs, for example, a one-pager with a full OLAP analysis or direct links to upstream IS is available (**Fig.** 7, right). The corporate dashboard, in turn, is the IS entry point for devices with limited screen size. Color-coding directs users' attention to critical points. Furthermore, navigational breadcrumbs, tabs instead of pull-downs, and direct links to upstream IS support easy-to-use, quick navigation within the MSS.

While the corporate navigator can be configured with the MSS software components for analyst users (**Fig.** 8, second line, MSS variant 3C, **Fig.** 5), it can be handled by consumer managers as well. In a mobile offline situation (for example, MSS variant 20, **Fig.** 3), these light users prefer to enter the MSS via exception reports with a picture, headline, and teaser followed by a "read more" function (**Fig.** 8, first line). The findings from our model suggest providing a PDF extract – we call it an "e-report" – to the user's e-mail account. Most often, just a few predefined reports are relevant for such extracts. Comments highlight deviations that require an immediate response. Page-by-page navigation leads to the dashboard of the division selected

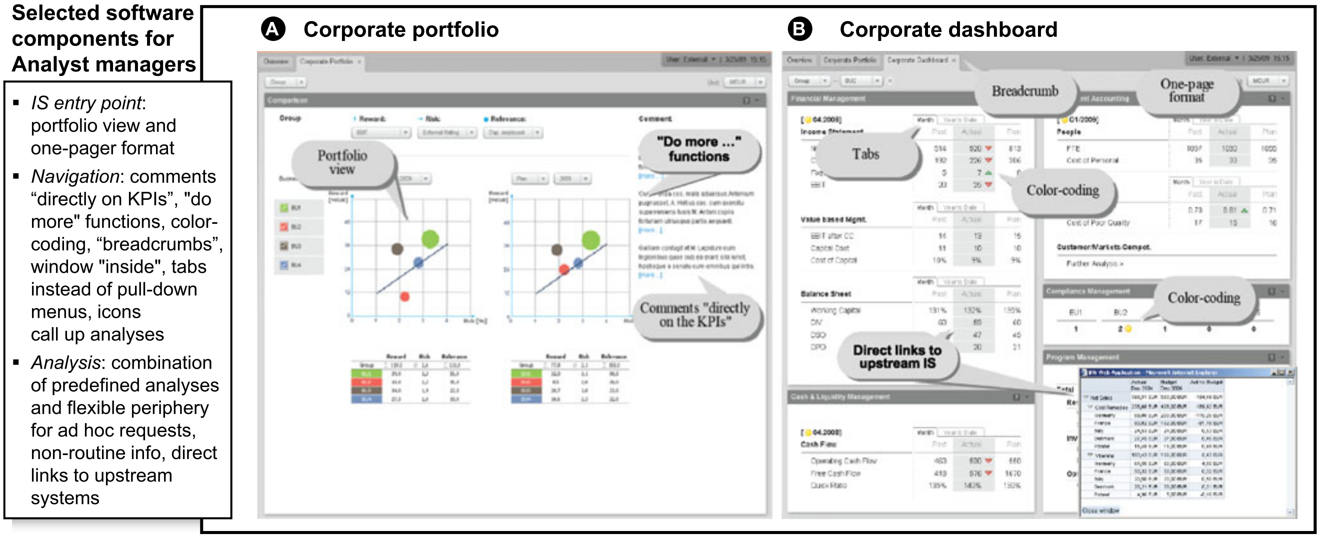

Fig. 7 Corporate portfolio and corporate dashboard for analyst users (screenshot from a pilot implementation)

from the corporate portfolio. **Figure 8** illustrates two situated MSS designs on different end-user devices – a tablet PC and a tablet – and the user-interface design with its software components for analyst users and consumer users as an example.

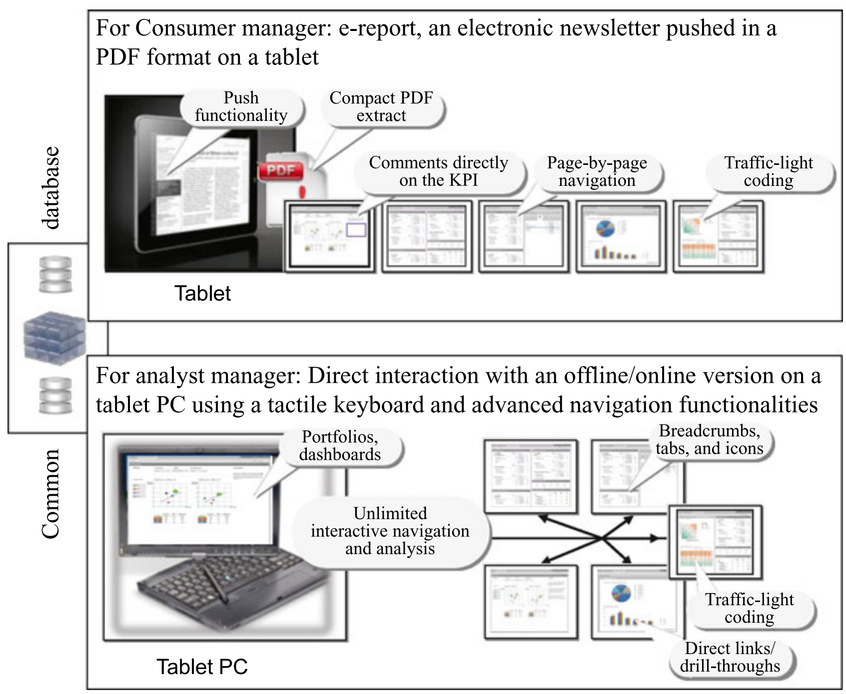

Fig. 8 Navigation schema of two situated variants of MSS design (screenshots from the pilot implementation)

5 Evaluation

To evaluate our call for situational MSS design, we test the influence of different use situations on MSS design choices. The more user preferences for end-user devices and appropriate user-interface software components differ, the more relevant is our call for situational MSS design.

To do so, we turned to an expert focus group. Although this group did not evaluate our situational approach in a real work environment, it provided direct suggestions and immediate feedback in a personal working atmosphere (Kirsch et al. 2007). Our focus group consisted of 42 participants from 25 different companies (**Table 3**). They belong to a working group of executives (L1) and "level 2 managers"[12] who have been meeting three times a year since 2006 to examine trends in executive IS support and "managing a company." They represent a fairly even balance among group executives, directors of accounting and other accounting professionals, BI directors, and divisional executives. Data were obtained in a three-hour moderated workshop in November 2010. **Table 3** summarizes the characteristics of the group's members and their companies.

The workshop began with an introduction by two facilitators. To provide common ground, participants were given 30 minutes to try out the following end-user devices: Apple iPhone 3GS (smartphone), Lenovo X200t (notebook) and Apple iPad (tablet). Then, we presented software components implemented in the Corporate Navigator for another 30 minutes. Participants finally had 60 minutes to fill out a questionnaire based on three use situations from **Fig. 3** likely to

[12]The L2 managers all have responsibilities that are comparable to that of C-level managers in smaller companies. Although they did not exclusively consist of L1 members, the focus group delivered results that should be representative regarding the relevance of our configuration model for top managers.

Table 3 Sample characteristics of the expert focus group

Position	No.	%	Sector	No.	%
Executives (L1)	13	31	Industrial	12	49
Director business department (L2)	23	55	Financial Services	3	11
Director IT/BI department (L2)	6	14	Other Services	10	40
Total	42	100	Total	25	100
Age			**Market capitalization [bn USD]**		
≤40	12	28	≤30	12	48
40-45	4	10	30-90	10	40
46-50	22	52	90-120	2	8
>50	4	10	> 120	1	4
Total	42	100	Total	25	100
Working style			**Frequency of MSS use**		
Analyst	21	50	Permanent	8	19
Consumer	21	50	Multiple times a day	14	34
Total	42	100	Once every day	6	14
Gender			2-3 times a week	8	19
Female	10	24	Once a week	6	14
Male	32	76	Total	42	100
Total	42	100			

occur in managers' day-to-day business:

(A, use situation #3): Analyst MSS user (working style), analyzing data alone (MSS use case) in an mobile offline MSS access mode – e.g., working in a plane

(B, use situation #7): Analyst MSS user (working style), presenting data to an audience (MSS use case) in a stationary MSS access mode – e.g., presenting the group financials in a board meeting

(C, use situation #32): Consumer MSS user (working style), analyzing data alone (MSS use case) in a mobile online MSS access mode with disruptions – e.g., sitting in a train with limited Internet access

We asked the participants to vote on the 17 user-interface components (**Table 4**). To inhibit the influence of the end-user-device selection, participants assumed using a notebook and they voted using the format: (1) strongly disagree, (2) disagree, (3) neither agree nor disagree, (4) agree, and (5) strongly agree. To evaluate our configuration model, we calculated arithmetic means (μ) and standard deviations (σ) for their responses. Furthermore, we performed a two-sided t-test to determine the significance of differences in mean value.

Table 4 shows the results. It reveals that the influence of different use situations (working style, MSS use case, and MSS access mode, along with the selection of the end-user device) is highly significant for most of the user-interface software components we considered. We distinguish between three levels of significance: The symbol "***" means that the deviation of the means is significant to a level of 0.01 (1 percent), while "**" indicates a level of 0.05 (5 percent) and "*" a level of 0.1 (10 percent). Although no significant deviation is evident between use situations A–C in a few cases (e.g., software component 1, 3), we found highly significant deviations for nearly all the other user-interface software components, especially the number of clicks tolerated for an analysis (5), the "do-more" function (9), direct links to predefined analyses (11), and ad hoc analysis (17). Together, these findings constitute a strong call for situational MSS design.

Furthermore, the results reveal that the use factors with the most impact vary depending on the use situation. This finding proves that determining user-group preferences along a single dimension is not sufficient and that the proposed situational MSS design can better accommodate the growing range of working styles, MSS use cases, and MSS access modes than the state of the art (Sect. 2).

6 Outlook and Future Research

By proposing configuration mechanisms for tailoring MSS to managers' different use situations, this article argues for situational MSS design. The configuration model covers managers' growing range of user-group preferences expressed by three use factors: working style, MSS use case, and MSS access mode. Furthermore, our model incorporates the selection of end-user devices and their appropriate user-interface design as two main levers of MSS configuration. Applying concrete configuration mechanisms, we demonstrate utility of our approach by means of a situated MSS prototype. Findings from an expert focus group confirm the value of this approach and contribute to our call for situational MSS design. However, we do *not* deliver concrete MSS software components for this configuration.

Our research on user-group preferences and situated MSS designs exposes several avenues for future research. Although our work followed a rigorous research process, the literature review covered a limited number of publications. For example, publications from practitioners could help to illustrate relevant MSS use situations and to expose important configuration mechanisms. A second limitation is the number of use factors, which was restricted to ensure a manageable number of use situations. In particular, managers' working styles should be captured in greater detail in the future. Gender, age, temperament, self-efficacy in IS knowledge, level of expertise, prior IS experience, and past device usage pattern might be important here, as well as cultural factors. Future MSS research should consider that requirements may change more rapidly. Autonomic and autonomous computing should help to handle this issue (Sect. 2.2).

Furthermore, the 36 use situations should be examined one by one to show the priority of the most important ones or delete those that are not likely to occur from our decision tree (**Fig. 3**). The same is true for the MSS configuration levers. The end-user device selection was

Table 4 Evaluation results of queried MSS user-interface software components

		Description of user-interface components	A μ	A σ	B μ	B σ	C μ	C σ	A, B	A, C	B, C
									*** = 1%, ** = 5%, * = 10%		
Information presentation											
	1	First orientation by picture, headlines and teasers with a "read more" function	3.29	1.65	3.76	1.26	3.71	1.38	*	-	-
	2	Corporate overview entry with symbols for single reports	3.48	1.40	4.14	0.96	3.38	1.47	**	-	*
	3	Visual analysis tools by 1-3 clicks (filtering, compare, correlate, and incorporate details)	3.76	1.26	4.00	0.84	4.19	1.44	-	-	-
	4	More than 3 clicks for 2-dimensional number based analysis (MS Excel)	3.90	1.04	3.00	1.10	2.19	1.17	***	***	**
	5	More than 5 clicks for n-dimensional analysis (drag & drop for OLAP analysis)	3.76	1.51	2.24	1.38	1.62	1.12	***	***	***
Dialog control											
	6	Static, predefined display (page-by-page navigation)	3.10	1.34	4.05	1.02	4.38	0.74	***	***	-
	7	Interactive display (filter, drill, calculate, sort, rank)	4.55	0.76	3.55	1.28	2.48	1.25	***	***	**
	8	Navigational breadcrumbs	4.21	0.98	3.26	1.28	3.11	1.20	**	***	-
	9	Do more-function (expose additional report/graph features)	4.57	0.75	3.90	0.94	2.95	1.32	***	***	***
	10	Sliders to adjust variables	4.20	1.01	3.20	1.24	2.62	1.36	***	***	*
	11	Direct links to predefined analysis (e.g., net sales by product, country, etc.)	4.55	0.61	3.65	1.04	2.60	1.31	***	***	***
	12	Direct links for ad hoc reporting, non-routine information, and upstream IS	4.38	0.74	3.57	1.12	3.43	1.17	***	***	-
Analytical functions											
	13	Topic-monitoring (is scanning reports for selected key topics automatically)	4.05	1.05	3.30	1.34	3.37	1.30	**	*	-
	14	Follow comments in a (firm-intern) blog (including a notification when other users add new comments in a followed blog)	3.76	1.38	2.71	1.52	2.38	1.36	***	***	-
	15	Statistic functions (e.g., regressions)	4.19	0.98	3.10	1.34	2.75	1.52	***	***	-
	16	Semantic search (searches for meaning not only words)	3.95	1.12	3.24	1.34	2.71	1.31	***	***	-
	17	Ad-hoc analysis	4.55	0.61	3.50	1.43	2.40	1.60	***	***	***

laid out only schematically in this article. It should not be too difficult to define a company-specific profile, but how to generalize patterns for making such a selection while bearing the different use situations in mind should be another topic of future research. In terms of the configuration levers, most MSS today are still developed to operate only on a particular end-user device, usually the PC. The need to access MSS in different use situations with different end-user devices creates a need for software components that can be deployed on a variety of devices. Defining software component clusters should also be a future research topic: which components are mandatory for proper MSS design, which are optional, and what clusters could provide a distinct structure to the vast number of potentially relevant software components.

More generally, the expert focus group did not constitute the kind of "real world" evaluation required for the instantiation of the proposed configuration model. Thus, a next design cycle with a systematic, broader evaluation should follow. Furthermore, we should not forget the functional perspective on MSS design. In addition to the lessons learned from the 2008/2009 economic crisis, ongoing environmental volatility for companies as of 2011 is the "new" normal and its impact on MSS content is worth discussing. Finally, the findings here should be applicable to other IS domains as well and thus contribute to improve IS design in general.

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Abstract

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Situational Management Support Systems

Accommodating the Growing Range of Working Styles, Use Cases, and Access Modes

Digital natives increasingly populate organizations' management. These new-generation managers more naturally accept management support systems (MSS), but also have higher expectations about how they should accommodate their individual user preferences. As a result, managers question MSS that have been developed without configuration mechanisms to accommodate their working style, relevant MSS use cases, and different MSS access modes. The objective of this article is to reveal managers' different MSS use situations and propose levers for tailoring (conceptual) MSS design to them. Use situations generalize classes of similar user-group preferences. We first apply findings from a literature review to cluster managers' user-group preferences into 36 MSS use situations. Second, we propose that the selection of end-user devices can serve as a main lever for MSS configuration. Third, we complete the configuration with a MSS user-interface design. Finally, we demonstrate utility of our configuration model by presenting and evaluating a prototype.

Keywords: Management support systems (MSS), IS analysis and design, User-group preferences, Use factors in MSS design, MSS configuration

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