Self-Service Management Support Systems: Findings from a New-Generation Manager Perspective

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Abstract New-generation managers are increasingly populating organizations' management. They consist of digital natives who grew up with Information Systems (IS) and digital immigrants who learned to engage with IS as adults. Today, such managers have to make faster decisions than in the past and find themselves more and more in mobile IS use situations. These requirements combined with managers' ability to use IS themselves result in the need for self-service Management Support Systems (MSS). This article develops a more business-driven design for such MSS. In doing so, we propose both a rigorous set of requirements and initial design guidelines to start further discussion. The utility of these guidelines is demonstrated with a "mobile-first" prototype on a modern business intelligence platform: the Corporate Navigator app.

1 Design Problem

The ability to make decisions on a rational basis about the "...configuration of resources within a changing environment, to meet the needs of markets and to fulfill stakeholder expectation" [1] distinguishes a *manager* from a knowledge worker [2].

Information Systems (IS) intended to help managers are known as *Management Support Systems (MSS)*. They have been a topic of research in the last 50 years [3–7] and serve as an for umbrella term for Management Information Systems (MIS),

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Decision Support Systems (DSS), Executive Information Systems (EIS), and more recently, Knowledge Management Systems (KMS) as well as Business Intelligence (BI) systems for managers [8, 9].

New-generation managers criticize MSS for their lack in accommodating their multifaceted work (functional requirements) and their individual attitude toward IS (non-functional requirements, [7, 10, 11]). They consist of both *digital natives* who grew up with IS as well as *digital immigrants* who learned to engage with IS as adults and developed into IS users over time [12].

From a *functional perspective* new-generation managers have significantly expanded their role in operations—in parallel to their strategic leadership. And they have to make decisions faster than in the past [13]. From a *non-functional perspective* they ask for better "IS design for use" [14]. Additionally, new-generation managers have to handle more and more *different IS use situations*, especially mobile situations such as traveling by train, plane or car with a driver [15].

These requirements combined with the managers' ability to use IS themselves result in the need for *self-service* MSS leveraging new IT-enablers—instead of relying on their assistants [16–18]. Among others, these IT-enablers include in-memory technology, which enables managers to see their data in real-time [19] and smart devices (e.g., tablets), which offer a convenient way to access the MSS—especially in mobile IS use situations [20].

Under these considerations, the objective of this article is to develop a more *business-driven MSS design*. Business-driven hereby means to consider not only what is technically possible, but what is economically feasible [21]. In doing so, we propose both a rigorous *set of requirements* and initial *design guidelines* to start further discussion. The utility of these guidelines is demonstrated with a "mobile-first" prototype on a modern BI platform. We answer two research questions:

- What is a rigorous *set of requirements* handling the new-generation managers' need for self-service MSS?
- What are initial *design guidelines* for such a MSS design to start further discussion and are these guidelines useful in practice?

Following the emerging tenets of design science research (DSR) in IS [22], we follow a six-step process model by Peffers et al. [23]. Sect. 1 motivates the research by introducing new-generation managers and their requirements for a self-service MSS leveraging new IT-enablers. Then, the under-lying research model and findings from a literature research are discussed and summarized in a set of requirements for self-service MSS (Sect. 2). By applying these requirements in a multi-case study, design guidelines are developed from the findings (Sect. 3). Their utility is demonstrated with a "mobile-first" prototype on a modern BI platform (Sect. 4). The evaluation covers both the DSR in IS process and the developed artefact of initial design guidelines (Sect. 5). Finally, we conclude with a summary, limitations and avenues for future research. This work is based on our prior work which presented the set of requirements [21] and exposed the prototype [24].

2 Requirements Analysis

2.1 Literature Review

We followed vom Brocke et al.'s [25] four step process for literature research and focused on leading IS research outlets provided by the London School of Economics [26]. We reviewed the outlets via AIS Electronic Library, EBSCO host, ProQuest and a standard Google search was used to cover recent contributions from practice [21].

A first keyword search, focused on MSS and management reporting, led to unsatisfactory results in terms of quantity and quality to start our research. As a consequence we did both expanding our journal base with six high impact accounting journals and complementing our search string with "management accounting system," "management accounting," and "schedule". The final search string (see Fig. 1) applied on the new journal base yielded a total of 759 hits. After qualifying the titles and scanning the abstracts a final back and forward search led to 63 relevant publications overall (see Fig. 2).

The findings of our literature review expose the following shortcomings (Fig. 2, in detail, [38]):

(1) *Lack of MSS user requirements focusing on management reporting*. There are 28 publications regarding user requirements, but most of them do not focus on management reporting. For example, Tricker [27] describes manager information needs without stating specific reporting requirements. Both, Aders et al. [28] and Cheung and Babin [29] examine individual aspects for decision-making, such as the selection of relevant data sources and KPIs, but they do not incorporate these into a comprehensive MSS design. Furthermore, the researched list approaches lack a rigorous framework for requirements development [30]. In addition the researched requirements lists are most often outdated [5, 31] or do not cover the requirements of new-generation managers [32].

(2) *Lack of MSS design guidelines for management reporting applying new IT-enablers:* 14 out of 63 publications cover methods which describe how to

	OR					
AND	Management support system	Executive information system	Management accounting system	(Group) decision support system	Management information systems	Business intelligence
	OR Schedule	Stakeholder	Recipients	Management board	Board of directors	
	Management accounting	Requirements	Reporting	Report	Management	

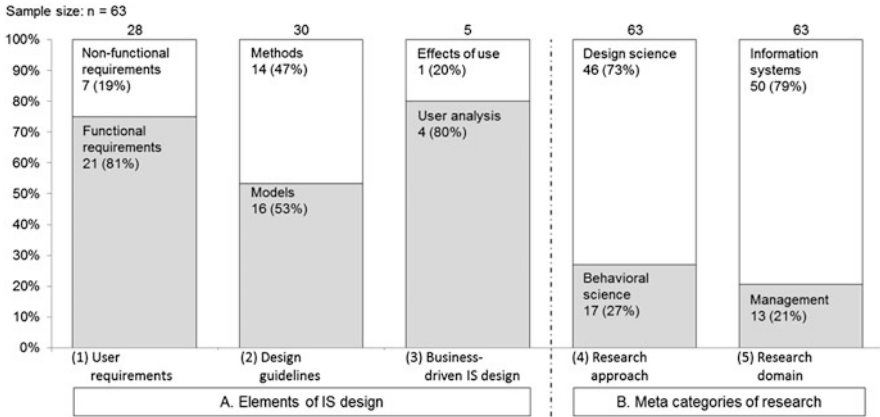**Fig. 1** Keyword search string (taken from [21])

Fig. 2 Classification of the publications (taken from [21])

build MSS whereas 16 out of 63 publications focus on models. These publications provide insight into what information is reported and which methods such as environmental scanning are applied [33]. Nevertheless they neither cover how information should be presented nor how new IT-enablers can be applied accommodating new-generation managers user-group preferences. The only publication in which principles for MSS design based on a rigorous criteria list are derived is from [11], but they do not leverage new IT-enablers.

(3) *Business-driven IS design is comprehensive:* With only five publications covering business-driven IS design guidelines for MSS, we identified another gap. A configuration model accommodating different manager working styles was proposed by Mayer et al. [14]. Furthermore, Armstrong et al. [34] analyzed managers' cognitive styles and propose a better MSS design by using different modes of information presentation and the flexibility of interfaces for different working styles.

(4) *Research approaches could be more differentiated*: Three out of four publications applied DSR in IS. We propose twofold that more research should be conducted with a behavioral approach and that more artefacts in DSR in IS should be evaluated by the means of a multi-case study.

(5) *MSS with a focus on management reporting is covered neither in IS nor the management literature:* We examined only 13 publications in management literature on this topic. These publications only address external reporting to capital markets [35]. Publications covering the internal reporting only consider what should be reported [36, 37] and to whom [27], but do not develop concrete design guidelines.

Summarizing our findings, there is a lack of a rigorous, ready-to-use set of business-driven user requirements from a new-generation manager perspective. Additionally, design guidelines for designing self-service MSS are conspicuously absent as well.

Table 1 Set of requirements for MSS design and evaluation (taken from [21])

Principle of economic efficiency	Design criteria		Evaluation criteria		Description
Solution capabilities (IS output)	Strategic positioning (WHAT)	Purpose	EC	1	Stakeholder and complementary reports for additional recipients [27, 39]	Who are the recipients of the report? What is the coverage and volume of the reports?
	Conceptual design (HOW)	Content	EC	2	Key performance indicators (KPIs) [17, 28, 40]	What KPIs are primarily used? Are they traceable by a value-driver-tree?
			EC	3	Dimensions of analysis [17]	Which information clusters are covered? How are the performance indicators split up? What is their temporal reference?
			EC	4	Advanced performance management [33, 41, 42]	Which ancillary concepts are applied in the management reports? Compliance/risk management, environmental scanning? Exception reporting: Is it possible to define exceptions?
		Visualization	EC	5	Graphical design and data visualization [43–45]	How is the first "look&feel" and is the basic screen design consistent? How is the report's understandability? What kind of standard or advanced charts are used to visualize information?
		Process	EC	6	Reporting process [6]	When are which reports provided to recipients?

Table 1 (continued)

Principle of economic efficiency	Design criteria		Evaluation criteria			Description
						When do the recipients discuss the reports?
	Business/IT-alignment	Flexibility	EC	7	Flexibility [14, 44]	How flexible is the MSS for accommodating individual information requirements and working styles?
	IT components (WHAT WITH)	New IT-enablers	EC	8	Mobile use scenarios [46, 47]	How comfortable is it to adapt stationary desktop design to smart devices (e.g., report transformation for smart devices)?
			EC	9	Different information media [48]	Are there different information media (paper, PDF, web, app) available to the recipients?
			EC	10	Collaboration/commenting [49, 50]	Is it possible to add comments to support collaboration across the company?
			EC	11	Real-time management [51, 52]	Is in-memory technology used to foster new kind of insights or faster processes?
			EC	12	Predictive analytics on big data [30, 53]	Are techniques from statistics, modeling, machine learning and data mining integrated into big data?
Resource requirements (IS input)	Effort	Adequacy	EC	13	Cost and time adequacy [54, 55]	What is the budget and time allocation for MSS design and implementation? What is the budget and time allocation for MSS operation and maintenance?

2.2 Set of Requirements

Combining the validity of SEMs and the relevance for practice of less rigorous list approaches, our research to derive requirements for MSS design follows a three-step approach [11, 21, 38] (see Table 1).

In the first step we choose the *principle of economic efficiency* to structure the upcoming MSS criteria. It is a generally accepted paradigm in business research [56] and addresses the ratio between benefit and cost. Thus, we are not guided by what is conceptually or technically possible but apply what is economically feasible. While the MSS benefits are measured in system capabilities, the general resource requirements are covered by the MSS costs.

In the second step, we specify the principle of economic efficiency into design criteria. We structure them by St.Gallen's Business Engineering approach [57] and Mayer's specification for MSS design [17, 38]. Applying this approach there are 4 + 1 design criteria: Strategic positioning, conceptual design, business/IT alignment, IT components, and effort.

The layer "*strategic positioning*" covers the purpose of the MSS, *conceptual design* the content needed, as well as the process with which the content is generated. *Business/IT-alignment* covers methods, models, and tools to gain flexibility of the MSS and the *IT components* are covering new IT-enablers such as software and hardware. In terms of the IS' input, the *effort* to design and implement MSS analyses the adequacy of the amount of money and time spent.

In the final step, evaluation criteria are derived from our literature review and complemented by the findings from a manager expert focus group[1] to specify the more general design criteria and make them measurable.

3 Developing the Artefact

3.1 Survey Design and Sample Characteristics

To develop the design guidelines we applied the set of requirements in a multi-case study. *Case studies* are "... applications of an artefact to a real-world situation, evaluating its effect on the real-world situation" [58]. They enable in-depth examination of a topic which is adequate to a complex topic like MSS [59].

We propose a *multi-case study* for our research, obtaining more compelling and robust results across individual cases in contrast to a single-case study [59]. It is also easier to determine appropriate levels of construct abstraction from more than one case [60]. We meet Yin's proposal of about 6–10 cases for a multi-case study with

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[1] The manager expert focus group covers heads of management accounting or group BI of large inter-national companies listed in the FT "Europe 500" report (http://www.rcw.wi.tu-darmstadt.de/ccuss).

	Attributes	Case Companies					
General	Company	Company 1	Company 2	Company 3	Company 4	Company 5	Company 6
	Revenue [bn EUR, 2013]	39	60	33	16	74	17
	Employees [thousands, 2013]	161	230	177	47	112	66
	Industry	Raw material and technology	Tele-communication	Automotive and transportation	Manufacturing	Chemical	Software
Monthly Management Report	Number of [recipients]	23	90	60	26	100	7
	Number of [pages]	120	270	230	35	40	30-40
	MMR finished at [working day] every month	16	16	14-16	4	6	15-20
	Covered Information Clusters — Financial Accounting	●	●	●	●	●	●
	Management Accouting	●	●	◑	○	●	◑
	Cash Flow & Liquidity Mgmt	●	●	●	●	●	●
	Program Mgmt	●	*	○	○	●	◑
	Compliance Mgmt	●	*	○	○	*	*
	Advanced Performance Mgmt — Risk Mgmt	●	*	*	*	●	◑
	Environmental Scanning	◑	*	●	◑	◑	◑
	Integrated Exception Reporting	○	○	○	○	○	○
	Used IT-enabler — Mobile Usage Support	○	Webcockpit	○	iPad App	○	iPad App
	Collaboration	○	○	○	○	○	○
	In-Memory Technology	○	◑	○	○	○	◑
	Predictive Analytics on big data	○	◑	○	○	○	◑
	Needed [FTE] for report generation	2 1/2	4	10	2	n/a	8

Harvey balls show coverage of the topic in the respective MMR. An empty harvey ball is a Likert rating of 1 (very low) and a full harvey ball is a Likert rating of 5 (very high).
* Information is provided to the MMR recipients in additional reports, which are not integrated in the MSS.

Fig. 3 Case company description and excerpt of the multi-case study results

six different companies [59]. They are described in Fig. 3 by revenue, number of employees, industry and an excerpt of the multi-case study results.

Since "selection of an appropriate population [. . .] helps to define the limits for generalizing the findings" [61], we chose the companies from different industries but with similar size in terms of workforce and revenue. The study was conducted over a period of 6 weeks. We chose semi-structured interviews driven by our set of requirements and complementing observations as data collection method to finally explore best practices and design gaps in existing MSS.

3.2 Multi-Case Study

The representatives of the six case companies are heads of (group) reporting, management accounting, and planning and risk. Two of the four researchers and two company representatives were present at all times during the interviews to reduce subjectivity and ensure a comprehensive documentation of relevant information.

We chose a seven-step approach for data collection[2]: (1) Basic presentation of the MSS by the company's representatives and joint "Q&A" with the researchers to provide a general understanding of the MSS, (2) analysis of the (monthly) top management report and the associated executive summary ("front page"), (3) a semi-structured detailed interview using our criteria list, explaining each EC, and letting the company representatives respond.

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[2] This approach is based on suggestions from [59, 61, 62].

The interviews were either on-site or by telephone conference (see Table 1). Furthermore, we received the monthly management report to examine it on-site.[3] (4) The results were discussed afterwards by the researchers and documented in a spreadsheet. (5) This process was followed by one feedback round to discuss open questions with the company's representatives. (6) After all cases were documented they were rated on a 5-point Likert-scale[4] for every EC, where 1 is defined as "not covered or in use" and 5 as "fully covered or leveraged". The rating was done in a discussion by the researchers. (7) This was followed by a presentation of the results in a workshop with all companies. Finally, the rating was discussed and with small adjustments the data collection was finished.

3.3   Develop Design Guidelines

The cross-case analysis exposes either design gaps or "best practices", both listed in Fig. 4. We depict the rating of each company's monthly reporting by each EC, the
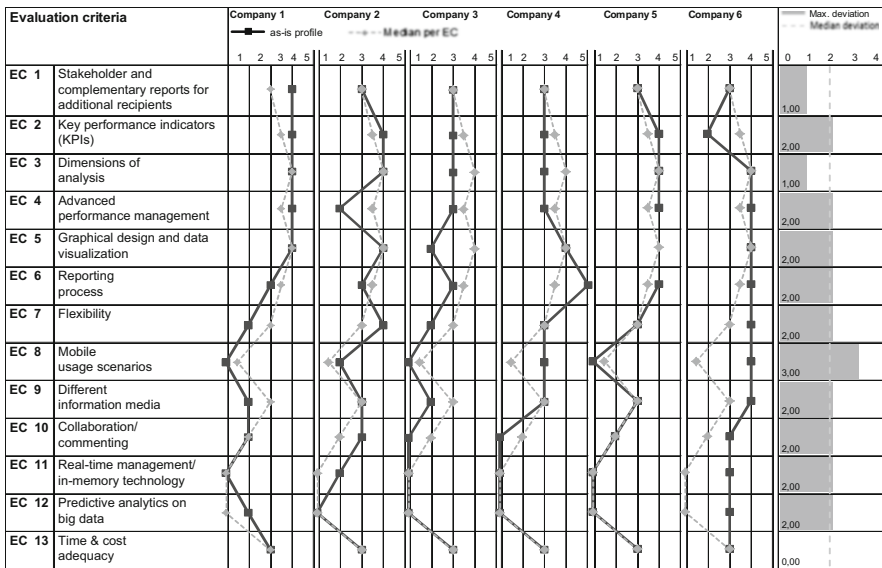

Fig. 4   Ratings of the case companies per EC and deviation analysis

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[3] Solely one company denied an insight into their management report due fear of disclosure of its content. Their results are based on their explanation of their MSS.

[4] Since a 5, 7, and 10 Point scale seem to perform roughly equivalent, we chose a 5-point scale because it can easily be represented as Harvey Balls [63].

median over all cases per EC,[5] the maximum deviation per EC, and the median of the deviation to outline the biggest deviations over all ECs. The differences between as-is values and the median values per EC gives an indication towards the positioning of a case within the six cases. The maximum deviation shows the heterogeneity of a single evaluation criterion and is supported by a median over all EC.

More in detail, the median of all cases over all ECs is "3." Looking at the maximum deviation the most values are coincide with the median (2). This shows that there is moderate, but uniformly deviation between the different companies in terms of fulfillment of the particular ECs.

Finding 1 (EC 1): There are different approaches of monthly management reporting. The examined cases vary greatly by scope, extent, and the number of MSS recipients such as quick overview vs. comprehensive reference book.

Because of different reporting scopes, the MSS reports have a heterogeneous volume in terms of number of pages (30–270 pp.) and recipients to be addressed (7–100 people). Except for one case (Company 5), the number of pages is roughly positive correlated to the number of recipients. In this regard the full MSS reports are mostly received by first and second level executives and corporate functions (SVP). Third level executives receive only excerpts specific to their area of responsibility, if any at all. The supervisory board is mostly supplied with an excerpt or summary of the MSS reports.

> **Design guideline 1**
> Design MSS as a single point of truth for all relevant stakeholders. Satisfy different information needs by offering a management summary and more detailed analyses of different types such as drill-downs, OLAP analyses and real-time operations.

Finding 2 (EC 2–4, 12): While environmental scanning topics are integrated, the MSS mostly focuses on financial KPIs and fail to include exception reporting as well as additional information sources.

KPIs from financial accounting and cash flow and liquidity management have a strong presence in the MSS reports. The coverage of management accounting, program management, and compliance management are less in the focus of current MSS. They are often reported separately. Methods such as predictive analytics on big data to gain novel insights from new data sources are not leveraged.

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[5] This cannot replace an as-is and to-be comparison, but because of the lack of the latter this should be a viable first indication for finding design gaps in today's MSS as well as spotting best practices from already satisfying ECs.

Design guideline 2

Establish MSS as the one-stop-shop by covering most important information clusters including non-financial metrics. Integrate environmental scanning, risk reporting, as well as exception reporting to provide a broad overview over the company's health.

Finding 3 (EC5): While an uncluttered report design is predominately implemented, clear guidance in how to use a report are scarce. Regarding the visualization, there are mostly simple bar and line charts in use.

Looking at the look & feel and understandability, the majority of MSS have recently been redesigned using state of the art design guidelines for effective report design. Therefore most of the redesigned reports meet high standards of quality. Microcharts are seldom used, even though they offer a good overview in a small space. Besides tables, simple bar and line charts are still dominating the reports. The use of indications and highlighting is mixed. Value-driver trees are used in every second company. Only one company uses a dedicated legend page to explain charts and color-coding.

Design guideline 3

Provide a concise look & feel within the MSS through a consistent color-coding. Use indications, highlighting, and advanced charts to expose relevant topics. Have a clear and consistent design concept and enrich pure metrics with graphics. Consider a decomposition of value-driver trees with various KPIs.

Finding 4 (EC8-9): Paper-based reports are the standard reporting medium followed by static electronic documents.

The MSS reports are provided mostly in a static version either on paper or electronic PPT/PDF format. The digital versions usually offer shortcuts to navigate by clicking on information. Native mobile apps are rarely used to cater mobile IS use situations and leverage the capabilities of smart devices. More companies offer web-based user interfaces which are not optimized for mobile devices with smaller screen sizes.

Design guideline 4

Provide a mobile-first MSS on different information media which accommodates the IS use situations of new-generation managers. Caching of information helps to decrease the effect of limited connectivity in "mobile offline" IS use situations.

Finding 5 (EC10): MSS lack modern information media and therefore miss the possibility to leverage collaboration at its full potential.

The extent to which commenting is provided varies greatly from no commenting at all to comments for every significant performance indicator deviation. Due to the lack of interactive media the companies mainly employ management comments by the reporting departments. Company 2 has comments at the level of certain performance indicators and their deviations. Company 3 and 4 either have no commenting at all or provide management comments in different reporting strands. Advanced collaboration features such as interactive commenting and notifications within the MSS are missing altogether. Only Company 2 offers the capability to share contents from within the web application which basically is a shortcut to an email client.

> **Design guideline 5**
> Use in-line comments to explain deviations on the most important performance indicators. Features to enable collaboration should be implemented as well to further facilitate self-service MSS use.

4 Demonstrate

4.1 Project Description

To demonstrate utility of our derived design guidelines, a prototype—the new Corporate Navigator app—was developed over 6 months starting in October 2013. It was developed by the authors of this paper with the help of a BI company called MicroStrategy, a vendor for BI software. Based on a software evaluation by Hauke et al. [38], MicroStrategy Analytics Platform [64] in the version 9.3.1 was chosen for its rich selection of visualizations, simple user experience and state of the art mobile capabilities.

On the hardware side, the researchers chose Apple's iPad [65, 66] as tablets strongly increased their market share in comparison to laptops [67].

4.2 The Corporate Navigator Framework

The Corporate Navigator framework and its first instantiation by Marx et al. [11] is based on the St.Gallen Business Engineering framework [57] and consists of *four design layers* comprising strategic positioning, conceptual design, business/IT alignment, and IT components to react flexibly to changing business requirements.

The starting point for the three-step standard reporting is the *Corporate Portfolio* which gives a graphical overview of strategic business units measured by a reward,

risk and relevance KPI. The *Corporate Dashboard* exposes in a one-page report format the most important KPIs at a glance, structured by the information clusters financial accounting, management accounting, cash flow- and liquidity management, compliance management, and program management. Information in these clusters can be further analyzed in a final reporting level: the *Corporate Analyses*.

4.3 The Corporate Navigator App

Reworking the Corporate Navigator prototype we have chosen a *mobile-first approach* with the iPad as end-user device. Following our design guidelines, we focused on a self-service design. The specifications were implemented by the BI engineer in an agile approach where all features for the day were defined in the morning, implemented during the day and finally reviewed by the researchers at the end of the day to ensure a good problem fit. A high-level overview of the specifications clustered by the design criteria are depicted in Table 2.

Table 2 Mapping between the design criteria, the specification of the prototype and contributing design guidelines

Design criteria		Specification of the corporate navigator app	Contributing design guidelines
Strategic positioning (WHAT)	Purpose	Three layers of analysis ranging from an overview with the three most important KPIs to fine-grained reports and detailed analyses. A digital management folder would provide ancillary information	1
Conceptual design (HOW)	Content	Leveraging non-financial KPIs by providing information from all five information clusters in dashboards and analyses. Provide the manager with exception reports to inform about critical issues	2
	Visualization	Consistent color coding by highlighting actual KPIs which performed worse, all other KPIs remain black. Provide a view for simulations with a value-driver tree. Sparklines leverage their potential on the Corporate Dashboard by providing a temporal context for actual values	3
IT components (WHAT WITH)	New IT-enablers	As an easy-to-use app on an Apple iPad the self-service MSS assists managers even when they are mobile and complements other information channels. Besides viewing comments for each KPI, topic or general matter, they can be composed by the managers to foster collaboration	2, 4, 5

Fig. 5 The corporate overview

Two of the specifications above are supported by MicroStrategy's analytics platform out of the box. Firstly, the platform synchronizes data between the server and the device whenever there is client/server connectivity. In the case the tablet has no connection to the server, data are cached in the MicroStrategy app and can still be displayed to support mobile online and offline use scenarios for managers.

Secondly, exception reports can be pushed to end-user devices as notifications. They include a description and a link to the most relevant report within the app. The manager can then follow the link and analyze the issue or make comments. Automatic notifications can also be received by subscribing KPIs or reports.

Other specifications are implemented within the analytics platform which follow the three-layered reporting structure. The *Corporate Overview* gives an overview and access to the three reporting levels of the Corporate Navigator (Fig. 5).

Comments next to the two important entry points—the Corporate Portfolio and the Corporate Dashboard—give the user guidance to navigate. In the bottom Sect. 5 Corporate Analyses views are visible. They are shown by default but further analyses such as a value-driver tree and geo maps are accessible by swiping to the left. Ancillary information which are provided in the form of PDF, audio or video can be accessed through a management folder.

Fig. 6 The corporate portfolio with collaboration bar

Starting a "typical" path of analysis, the *Corporate Portfolio* plays an important role. EBIT (earnings before interest and taxes), EBIT deviation and capital employed were selected as the most important KPIs for a reward, risk and relevance perspective on the companies' strategic business units (SBU). For collaboration a retractable toolbar was implemented. This bar is designed to follow the concept of "show more" and thus is only visible on demand, by taping on the commenting icon (see Fig. 6). By selecting a SBU in the table can navigate to the SBU's Corporate Dashboard.

The Corporate Dashboard (see Fig. 7) consists of five information clusters: financial accounting, management accounting, cash flow & liquidity management as well as compliance and program management, the latter covers an overview of most important projects.

As proposed in the design guidelines a forward-oriented perspective with actual, plan, and forecast replaces the traditional view of past, actual, and plan [11]. Sparklines are used to expose the general trend from the last 12 months. As a result from the expert focus group, deviations from actual and plan values were preferred over actual and forecast as well as plan and forecast. To quickly grasp the year-over-year growth the deviations are shown as absolute and relative values. Negative deviations of the actual values from the plan values result in a highlighting of actual values in red to guide attention towards important deviations (color-coding). The navigation concept includes the use of touch input gestures to switch between a monthly perspective and an aggregated year to date (YTD) perspective by swiping left and right over the whole screen. While a monthly perspective only

Fig. 7 The corporate dashboard

shows data points from the selected month, the YTD perspective aggregates the data points beginning in January of the selected year to the selected year month.

Links to more detailed analyses such as an Income Statement and Financial Accounting analysis; see Fig. 10 for more) which result in a transition to other views are distinguished with a cursor icon while analyses in the same view can be accessed through swipe gestures on dedicated areas. For instance by swiping the Management Accounting tile, net sales from the Financial Accounting on the left side can be examined more in detail on the right side (see Fig. 8). The analysis comprises a breakdown of net sales by region as well as customers and provides the option to leave comments.

Commenting at a KPI-level is supported in two ways. In both ways it shows contextual information on demand but either in a dedicated area in the screen (left, Fig. 9) or in a popup window (right, Fig. 9). Notification icons informing about further comments can be positioned freely throughout the interface and expose more information as soon as they are activated by a tap.

The *Corporate Analyses* add a third and final layer to the MSS. In Fig. 10 an overview of the analyses is given. All of the analyses serve a special purpose and the design is consistent following the derived design guidelines.
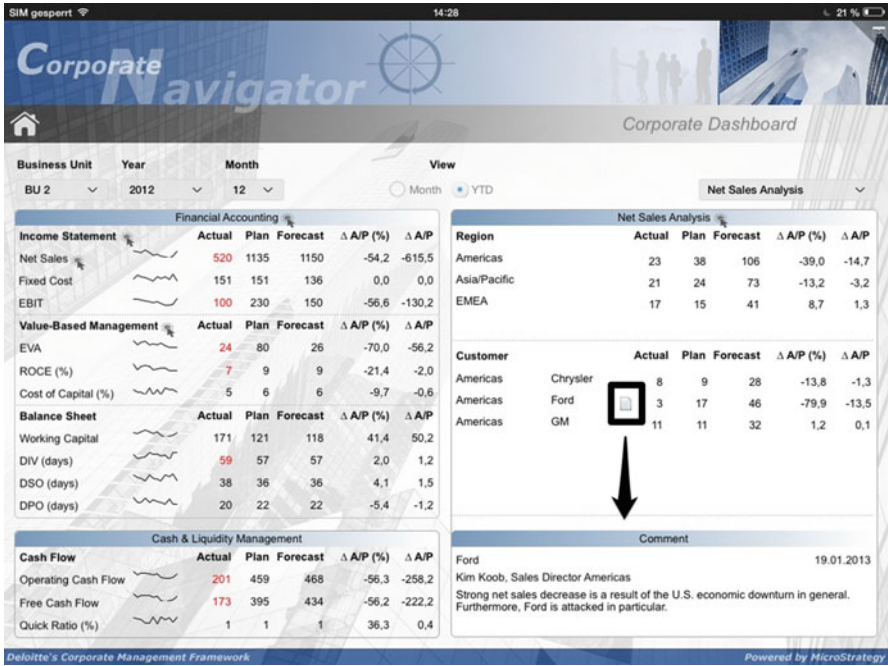
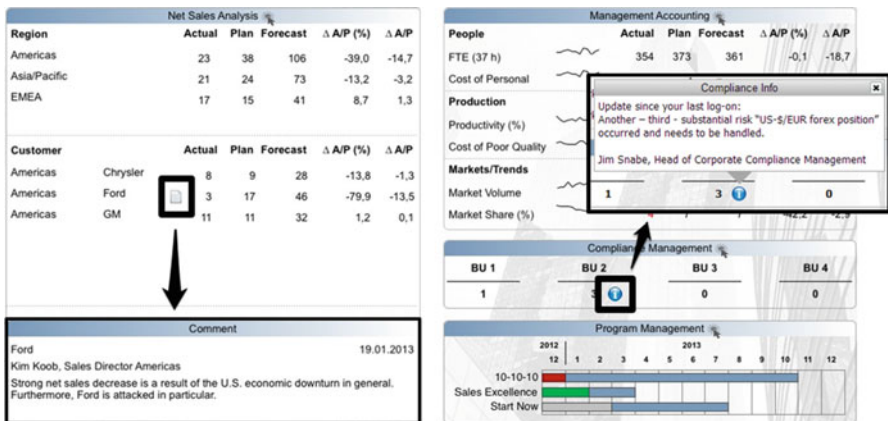Fig. 8 The corporate dashboard with net sales analysis

Fig. 9 Commenting at the KPI in the net sales analysis and compliance management

Fig. 10 The corporate analyses and management folder

5 Evaluation

Evaluation in the DSR in IS process has to „observe and measure how well the artefact supports a solution to the problem" [23]. Complementing such *utility*, we evaluate the rigorousness of the DSR in IS process on hand [68].

Since this work is part of a greater project in which the set of requirements were already evaluated [21], this section focuses on the ex-post evaluation of the design guidelines developed in this article. The evaluation took place in a naturalistic context which involves the interaction of real users with real IS to solve real problems [69]. We did the evaluation by interviewing two heads of corporate (group) reporting departments from German DAX companies. Both companies participated in our multi-case study.

The prototype was demonstrated in a semi-structured interview guided by the set of requirements developed before (see Table 1). The answers were qualitative. During the interview two authors of this paper rated the Corporate Navigator app in accordance to managers' assessments. The results from this process give an understanding of how well the design guidelines address the findings we identified in current MSS design and are summarized in Fig. 11.

The managers considered the condensed Corporate Portfolio and Corporate Dashboard design together with the flexibility of the Corporate Analyses as a
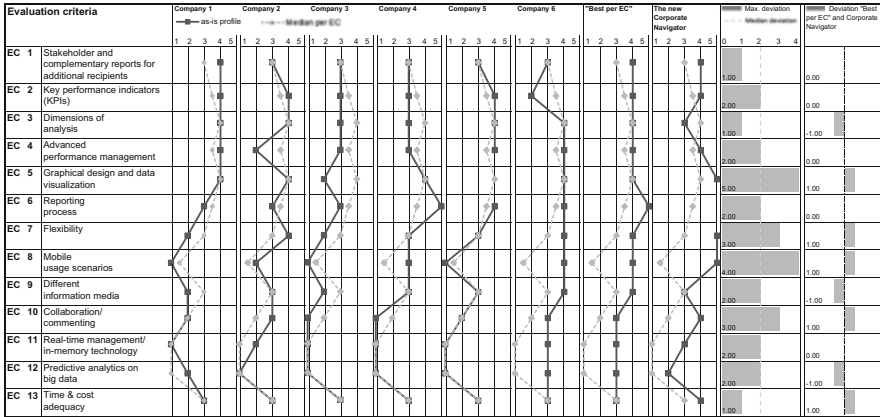
Fig. 11 Comparing the corporate navigator app with existing MSS

unique value proposition of the Corporate Navigator app. In combination with the management folder this MSS app can serve as a single point of information for new-generation managers. Due to the smaller screen on tablets and enlarged controls, there is less space left for more *dimensions of analysis* in reports. Thus, interviewees perceived the capabilities in this area as inferior to top class.

However, a balanced relationship between *financials and non-financials* through the five information cluster resulted in an on par rating with the leading companies examined in the case study. By its incorporation, risk management, value-driver tree and environmental scanning, the *advanced performance management* convinced the managers as well. Only the driver tree showed room for improvement since it (a) assumes a single product company which is not often the case and (b) should offer more options to drill down on performance indicators.

The top ranking in the *graphical design and data visualization* arises from two factors. Firstly, a high usability is the result of a design adapted to the specifics of the information medium (i.e., app on a tablet) in combination with an intuitive navigation. Secondly, advanced visualizations such as sparklines, waterfall charts and geo maps contribute to an improved "look&feel" and lever their strengths especially in the restricted screen estate of a tablet.

Since delays in the *reporting process* are not the result of technical issues but organizational inefficiencies the Corporate Navigator app could not made improvements. This leads us to the conclusion that a rating here is not feasible.

The Corporate Navigator's *flexibility* is driven by the Corporate Analyses in which new reports can be seamlessly integrated. In addition, reports which shall be provided to stakeholders on a short notice can be viewed from the management folder within the app. Through the mobile-first approach *mobile use scenarios* are perfectly supported by the Corporate Navigator app, but lack the capability to export the information to further *information media* such as PDF or paper. To support the latter a print feature is needed.

Collaboration (mainly commenting) was appreciated by the managers as well since it is substantial to give a clear picture of the company's current situation and provide contextual information. Although, other IT-enablers such as *in-memory technologies* and *predictive analytics* are used in the Corporate Navigator app and their benefits has been acknowledged by the managers, the full potential has not been leveraged yet. Therefore the rating is limited in both criteria.

A strength of the predefined Corporate Navigator framework is resource efficiency. The project team needed just 21 man-days to implement the current state of the app and therefore undercuts the average implementation length strongly. Thus, the *cost effectiveness* is higher than in other custom implementations.

Overall the Corporate Navigator app represents significant progress towards self-service MSS to support new-generation managers and their multifaceted work.

6 Conclusion and Avenues for Future Research

The work at hand completes a greater research project[6] in self-service MSS for new-generation managers leveraging new IT-enablers. A set of requirements for self-service MSS was taken from prior research [21]. These requirements were used to evaluate six MSS of German DAX companies in a multi-case study. Based on the case study's findings, design guidelines for self-service MSS were derived and, then, evaluated by a mobile-first prototype: the Corporate Navigator app. To demonstrate progress in research an evaluation of the prototype with two companies from the multi-case study was conducted.

There are several limitations which lead to the following avenues for future research: Firstly, even if the principle of economic efficiency is well-proven, the *cost and time* to develop the MSS accessed in the case study could not be measured. This was a problem of confidentiality and amount of work put into quantifying the effort needed to build and operate the MSS by the case companies, rather than a fundamental flaw in the artefact or its demonstration itself. Future research should focus on obtaining a rating in this criterion.

Secondly, the lack of a *to-be profile* is a more serious limitation of this work. A first step towards developing a to-be profile could be that managers rate their satisfaction with the different aspects (e.g., on the evaluation or design criteria level) and their appeal towards self-service use of MSS.

Thirdly, the five design guidelines on hand can serve as recommendations to design self-service MSS with a focus on management reporting. However, our case study is only a *first snapshot*. We propose to observe the continuous validity of the guidelines. This may be of interest due to changes in user requirements and emergence of other IT-enablers. Future research should keep social and technical progress in mind as well.

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[6] [21, 24, 70, 71].

Fourthly, the design guidelines were evaluated by heads of corporate (group) reporting departments, thus it remains unknown how the *board of directors* would have evaluated the prototype.

Another avenue for future research could be the implication of ubiquitous information access through self-service MSS. The constant engagement with ICT (e.g., smart devices) creates so called *technostress* [72]. Thus future research could examine the effects of self-service MSS on the individual manager as well. This could lead to further design guidelines from a non-technical direction.

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