POWERING UP COMPANIES' CRYSTAL BALLS: ANALYSIS OF A MULTI-CASE STUDY TOWARDS MORE APPLICABLE ENVIRONMENTAL SCANNING SYSTEMS

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Abstract

The increasing volatility of their companies' environment is a growing concern for executives. IS-based environmental scanning that complements the accounting information system domain can help to manage this challenge. A substantial body of knowledge on such information systems exists, but these concepts often go unused in practice. This article develops five design guidelines for environmental scanning systems that are more applicable than those outlined in previous research. In doing so, we first compile a set of requirements based on the principle of economic efficiency, and then use findings from the absorptive capacity theory to specify them. Challenging several implementations against these requirements in a multicase study generates findings that we synthesize into design guidelines. They address diverse areas: designing a more comprehensive model for information gathering, setting up a collective learning process for interpreting information, using IS to enable management techniques familiar to executives, designing processes for more interorganizational integration of environmental scanning systems, and accelerating prototyping.

Keywords: balanced chance and risk management, regulatory needs, accounting information systems, new information and communication technology (ICT), case study research
1 Introduction

The 2008/2009 economic crisis provided a sustainable impulse for companies to focus earlier on emerging threats and opportunities (Makridakis et al., 2010)—and, as the volatile environment in summer 2011 demonstrated, the topic continues to gain relevance. Executives worry about not being prepared for environmental shifts or, even worse, not being able to parry them. Environmental scanning can help to manage this challenge, especially if it is information systems (IS)-based and complements the accounting information system (AIS) domain. The main functions of such scanning systems are to gather, interpret, and use pertinent information about events, trends, and relationships in an organization's environment to assist management in planning the future course of action (Aguilar, 1967). Companies that do so will have brighter prospects (Ansoff, 1980).

With Ansoff's (1975) article "Managing Strategic Surprise by Response to Weak Signals" as a flagship example, a substantial body of knowledge on this topic exists, but concepts often go unused in practice (Day and Schoemaker, 2005). Practitioners perceive the task as a difficult one per se (Lesca and Caron-Fasan, 2008), and encounter obstacles in design, implementation, and day-to-day operation. A current survey with executives from companies listed in the FT "Europe 500" report reveals that environmental scanning systems continue to lack applicability (Mayer, 2010). As a result, findings from environmental scanning systems are often not considered in executive decision making.

Increasing acceptance of IS among today's executives and technological advances of the Internet era (Vodanovich et al., 2010) make the present moment favorable for a redesign. This article develops five design guidelines for environmental scanning systems that are more applicable than those outlined in previous research. We first compile a set of requirements—prerequisites, conditions, or capabilities needed by the users of a software system (IEEE, 1990). Challenging several implementations against these requirements in a multicase study generates findings that we synthesize into design guidelines. These guidelines go beyond requirements in that they serve as predefined actions to make environmental scanning systems more applicable or bring new ones to life (Hoogervorst, 2009).

Our investigation adheres to design science research (DSR) in IS (Hevner and Chatterjee, 2010). The outcomes of this approach can be classified as constructs, models, methods, and instantiations (March and Smith, 1995). The set of requirements forms a model. The proposed design guidelines, in turn, contribute to theories specifying how environmental scanning systems should be designed based on kernel theories (Kuechler and Vaishnavi, 2008).

The paper is organized as follows. Lessons from the 2008/2009 economic crisis suggest that redesigning environmental scanning systems could help executives to focus earlier on emerging threats and opportunities. After arguing for complementing AIS architecture with such IS, we lay out the regulatory requirements (Sec. 2). Based on a state of the art, we specify the research questions (Sec. 3). We then derive a set of requirements for environmental scanning systems from the principle of economic efficiency and use findings from the absorptive capacity theory to specify them (Sec. 4). In Sec. 5 we describe our multicase study and present the findings. Building on these insights, we synthesize five design guidelines (Sec. 6). They should provide starting points for future research (Sec. 7).

2 Environmental Scanning Systems Complementing the AIS Domain

A company's environment is defined as the relevant physical and social factors within and beyond the organization's boundaries (Duncan, 1972). While operational analysis focuses on (short-term) internal difficulties in the implementation of strategic programs (Davies et al., 2006), strategic environmental scanning aims at anticipating (long-term) environmental shifts and analyzing their potential impact. This article concentrates on the latter, hereafter referred to as environmental scanning.

Environmental scanning systems have their roots in management literature (Aguilar, 1967) and focus on the awareness of environmental trends as an executive task (Narchal et al., 1987). These IS specify
the sectors to be scanned, monitor important indicators of opportunities and threats for the company, indicate the IS-based tools to be used, incorporate the analytical findings into executives' decision making and, in many cases, assign responsibilities to support environmental scanning. In the reactive mode, scanning acquires information to resolve a problem. We follow the proactive mode, which involves scanning the environment for upcoming opportunities and threats (Choudhury and Sampler, 1997).

From the IS perspective, enterprise resource planning (ERP) systems are widely used to integrate corporate operations. AIS are the nucleus of ERP systems (Deshmukh, 2006). As accountants shift from being "purely" financial bookkeepers to information professionals (Gelinas Jr. et al., 2011), AIS increasingly cover both financial and non-financial information. Thus, AIS today should not only include information for financial statements, internal controls, audit trails, or extensions for governance and compliance (Grabski et al., 2011) — they must support more forward-looking opportunity and risk management as well. In this respect, environmental scanning systems complement the "modern" AIS domain. If they are incorporated into AIS, they provide a prospective corporate management beyond "pure" financial and non-financial planning and reporting.

Environmental scanning is not just "nice to have," as Kajüter (2004) shows in his multicountry comparison. In the wake of several cases of fraud around the turn of the millenium that were detected neither by internal controls nor by auditors, legislators expressed the need for more detailed risk management within the AIS domain. The best known result is the U.S. Sarbanes-Oxley Act. In particular, Section 404 requires companies listed on the New York Stock Exchange to establish and maintain an adequate internal control structure and procedures for financial reporting. Furthermore, the annual report must contain an assessment of the effectiveness of these control structures and procedures, which the auditors must comment on in turn in the audit report (Sherman and Chambers, 2009).

As another example, § 91 II of the German Stock Corporation Act requires companies to implement early warning systems. Furthermore, capital-market-oriented companies must discuss their internal controls and their risk management in their annual statement status report (§ 289 V, German Commercial Code). This AIS regulation was a response to the 2008/2009 economic crisis. Last, but not least, financial statements are prepared on the assumption that a company will continue to operate for the foreseeable future (IASB Framework 4.1; ISA 1.25), making forecasts of at least one year necessary.

3 State of the Art and Research Questions

We structured the articles we researched in terms of the elements of IS design theories they employ. Fig. 1 illustrates our results within this framework. The approach is taken from prior work (Mayer, 2011) and the findings are based on Mayer et al. (2011), but expanded with another five publications.

Elements of IS design theories: According to Walls et al. (1992), IS design theories consist of three elements. (1) User requirements delineate what IS should do twofold (Kotonya and Sommerville, 1998). Functional requirements address "what" IS should or must do (purpose). Non-functional requirements reflect "how well" IS should perform within the given environment. IS design theories also cover guidelines for bringing the system to life, which contribute to models and methods. (2) Models outline concrete systems, features, or combinations of these (Gregor, 2006). We distinguish between forecasting as the first generation of environmental scanning systems, indicator-based models as the second, and environmental scanning using weak signals as the third. (3) Methods cover the process of environmental scanning. Here, we differentiate between methods for gathering information ("scanning"), analytical techniques to identify latent or pending changes ("use"), and the incorporation of the scanning results into executives' decision-making processes ("interpret").

Research methods: The research approach influences the granularity of requirements and design guidelines identified, from high-level findings regarding "appropriate technology" to detailed IS features such as "drill-down functionality to an upstream ERP." (4) Papers with a behavioral focus explain phenomena from practice. They rely on observation and apply empirical methods. We differentiate between case studies, experiments, and surveys. (5) Design approaches involve ideas and
frameworks for creating a "better world" and provide more direct recommendations for IS (Walls et al., 1992). In terms of design approaches, we differentiate between those focused on single items and list approaches and those that specify frameworks (sets of requirements and design guidelines).

Figure 1: Results of a current literature review (based on Mayer et al., 2011)

User requirements – lack of research on sound requirements analysis: Within the substantial body of knowledge, just six out of 85 publications focus on functional requirements, and only two on non-functional ones (Figure 1, first column left). Most of these, for example Frolick et al. (1997), follow a simple list approach without providing an overall structuring principle or second-level dimensions. None of the remaining approaches applies a systematic process to develop requirements criteria for environmental scanning systems. Thus, a first research question is how to generate a set of requirements for environmental scanning systems using a more rigorous approach than those identified in the literature, without losing practical relevance.

Models – weak signals lack the "grasp" to apply in practice: The most popular approach for finding indicators for proactive decision making is the use of weak signals (Figure 1, second column left). For this reason, we pursue this concept, but attempt to improve the "grasp" of these signals. It is not clear which environmental changes actually constitute weak signals and so proactively indicate significant trends. Differentiating weak signals from inconsequential day-to-day fluctuations is especially difficult.

Methods – lack of approaches for more closely incorporating environmental scanning results into executives' decision making: Environmental scanning is useless if the results are not integrated into executives' decision making processes (Figure 3, third column left). Our literature review reveals a gap in this area. Regarding model and method design, we try to develop design guidelines for environmental scanning systems that are more applicable than those outlined in previous research. What form these guidelines could take is our second research question.

4 Set of Requirements

To address the first research question, we followed Popper (2005) using the deductive method to define a systematic set of requirements for environmental scanning systems. As a starting point, we chose the principle of economic efficiency, which focuses on the ratio of cost and benefit and is a generally accepted paradigm in business (Samuelson, 1983) and IS research (Stair and Reynolds, 2011).

Although the cost of designing environmental scanning systems can be identified to some degree, the benefits of the indicators they deliver can be quantified to a limited extent only. To provide surrogates for these values, we use two basic criteria: solution capabilities and resource requirements (Fig. 2). Following the "black box" method, these criteria can be differentiated as follows (Matek et al., 1987): Solution capabilities cover how IS output supports environmental scanning for managers. Resource requirements, in turn, cover the input needed to generate the output.
Following Aguilar's (1967) process-oriented view, we categorize the solution capabilities as information gathering, interpretation, and usage capabilities (Fig. 2). In addition, we suggest cross-process factors that contribute to capabilities not subsumed by the previous categories. Resource requirements can be measured in terms of the effort required to set up environmental scanning systems.

The resulting design criteria are rather abstract. Environmental scanning contributes to a company's absorptive capacity (Zahra and George, 2002), so we examined this theory to define measurable evaluation criteria (EC). Fig. 2 illustrates our set of requirements: 20 evaluation criteria for applicable environmental scanning systems.

<table>
<thead>
<tr>
<th>Principle of economic efficiency</th>
<th>Design criteria</th>
<th>Evaluation criteria</th>
<th>Description (including references)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>EC 1 Coverage of strategic risks (vision and strategic program)</td>
<td>To what degree does the environmental scanning system include information concerning strategic risks (COSO, 2004)?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EC 2 Coverage of operational risks (internal and external value chain)</td>
<td>To what degree does the environmental scanning system include information concerning operational risks (COSO, 2004)?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EC 3 Coverage of information for regulatory compliance</td>
<td>To what degree does the environmental scanning system include information concerning regulatory compliance (Choo, 2009)?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EC 4 Consideration of chances (adhering company-specific chance/risk ratios)</td>
<td>To what degree does the environmental scanning system take account of monitoring chances, not only risks (Teewe, 2007)?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EC 5 Level of incorporated IS-support for information gathering</td>
<td>Does the environmental scanning system use modern IS to increase speed and intensity of information gathering (Oh, 2009)?</td>
</tr>
<tr>
<td>Solution capabilities (system output)</td>
<td></td>
<td>EC 6 Bias prevention</td>
<td>To what extent does the environmental scanning system provide methods or other functions to prevent biased interpretation (Volberda, 2010)?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EC 7 Level of knowledge and thinking process support</td>
<td>To what extent does the environmental scanning system provide explicit and tacit knowledge for interpretation (Lipschitz et al., 2001)?</td>
</tr>
<tr>
<td>Information usage</td>
<td>EC 8 Level of incorporated IS-support for information interpretation</td>
<td>To what extent does the environmental scanning system provide advanced functions for technical analysis (e.g., data mining, March and Hevner 2007)?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC 9 Quality of information presentation</td>
<td>To what extent is the interface design user-friendly and provide graphical or aggregated forms of information presentation (Jiang et al., 2000)?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC 10 User interface and dialog control</td>
<td>To what extent is the dialogue within the environmental scanning system comfortable and user-friendly (Houseshahi and Watson, 1987)?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC 11 Communication functionalities</td>
<td>To what extent does the environmental scanning system support internal and external communication functionalities (Papageorgiou and de Bryn, 2010)?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC 12 Ease of IS handling for information usage</td>
<td>To what extent does the environmental scanning system help for a better IS access and analyses (Papageorgiou and de Bryn, 2010)?</td>
<td></td>
</tr>
<tr>
<td>Cross-process factors</td>
<td>EC 13 Timeliness</td>
<td>How frequently is the data basis of the current environmental scanning system updated (Eisenhardt and Martin, 2000)?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC 14 Flexibility</td>
<td>How flexible (agile) is the current environmental scanning system to meet changing requirements itself (Papageorgiou and de Bryn, 2010)?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC 15 Accuracy</td>
<td>How important is it that your current IS provides information that cover reality in terms of the &quot;decimal places&quot; used (Walia and Carver, 2009)?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC 16 Consistency</td>
<td>How important is the reliability in terms of avoiding manipulation, disruptions, and mechanical failures (Jiang et al., 2000)?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC 17 Interorganizational integration</td>
<td>To what extent are external partners (supplier, customer or others) integrated in the environmental scanning system (Guadz 2000)?</td>
<td></td>
</tr>
<tr>
<td>Resource requirements (system input)</td>
<td>EC 18 IS transparency for cross-process factors</td>
<td>To what extent does the environmental scanning system lay open their algorithm of operations (Walia and Carver, 2009)?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC 19 Cost adequacy</td>
<td>What was the amount of money so far your current environmental scanning system costed (including maintenance, Zott, 2003)?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EC 20 Time adequacy</td>
<td>How much time has been invested so far in developing the current environmental scanning system (Zott, 2003)?</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2: Set of requirements for environmental scanning systems

5 Multicase Study in the Industrial Sector

5.1 Research design

We designed our research as a case study so that we could examine contemporary phenomena in its real-life context. Using Eisenhardt's framework (1989), we specify our research as follows. Our (i) aim and research design is to provide descriptions of four environmental scanning systems implemented in practice, including how "modern" Internet IS capabilities can contribute to them.

For (ii) data collection, we chose semi-structured interviews based on a questionnaire. Because this technique is more interactive than a survey, it should generate answers more suitable for our purposes, especially in terms of comparing several environmental scanning systems in practice and examining
their differences. The face-to-face interviews lasted 60 minutes each. We asked **predefined, but open-ended questions**. Such questions make it possible to obtain in-depth data while ensuring comparability between responses better than freeform interviews do (Fontana and Frey, 2000). Another consideration is the selection of appropriate cases (iii). Their number and individual characteristics can vary; existing research projects range from multilevel analyses of a single case study to comparisons of multiple ones. Assuming that different approaches exist to environmental scanning systems, we conducted a **cross-company analysis**.

Eisenhardt (1989) suggests that cases should offer extreme examples in which the aspect of interest is transparently observable. We concentrated on **large international companies** for several reasons. First, they should have resources in quantity and quality to pursue activities such as environmental scanning seriously. Second, regulations for stock-listed companies require environmental scanning systems. Third, capital markets punish negative developments at large companies faster than at small or medium-sized ones. Furthermore, we chose companies from the industrial sector, as they indicated to a greater extent than financial companies that handling uncertainty has become more difficult (Mayer, 2010). As summarized in Table 1, we selected four companies of varying size in different industrial sectors. To obtain our data, we selected interviewees based on their knowledge and hierarchy level.

<table>
<thead>
<tr>
<th>A. Company characteristics and interviewees</th>
<th>Company A</th>
<th>Company B</th>
<th>Company C</th>
<th>Company D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>€ 47.97 bn</td>
<td>€ 60.87 bn</td>
<td>€ 2.98 bn</td>
<td>€ 15.47 bn</td>
</tr>
<tr>
<td>Employee</td>
<td>182,425</td>
<td>243,275</td>
<td>12,971</td>
<td>47,768</td>
</tr>
<tr>
<td>Assets</td>
<td>€ 43.71 bn</td>
<td>€ 127.76 bn</td>
<td>€ 3.77 bn</td>
<td>€ 17.28 bn</td>
</tr>
<tr>
<td>Industry</td>
<td>Steel, engineering</td>
<td>Telecommunications</td>
<td>Optical systems, measuring equipment and medical devices</td>
<td>Chemicals, consumer products</td>
</tr>
<tr>
<td>Department</td>
<td>Corporate controlling</td>
<td>Corporate risk management</td>
<td>Corporate business intelligence</td>
<td>Corporate risk management</td>
</tr>
<tr>
<td>Interviewee</td>
<td>Senior Expert</td>
<td>Head of department</td>
<td>Head of department</td>
<td>Senior Expert</td>
</tr>
</tbody>
</table>

**Table 1**: **Researched companies and their environmental scanning systems**

The final aspect of our research design is (iv) data analysis and presentation. We performed a **one-time analysis** and gave participants a chance to comment on our protocols within a week after their interview. Two researchers were involved: one concentrated on interviewing and one on documentation. Once all the interviews were completed, we performed **cross-comparisons**, contrasting interview data according to the research question. In particular, we cross-checked the as-is values against the requirements the interviewees mentioned (to-be values).

### 5.2 Within-case results: objective, maturity, and focus group

Company A is a steel and engineering company. Its environmental scanning system is developed and maintained by the corporate controlling department (Table 1). After governance was centralized at headquarters, the company began a redesign in 2010 to a more **centralized environmental scanning system in a formerly decentralized company**. The IS is therefore at an early stage of maturity and
provides information to executives at the group and division level. Headquarters sees itself as a service provider to the divisions, offering them centralized scanning governance, processes, and templates.

Company B is a telecommunications company. Before the 2008/2009 economic crisis, environmental scanning there was focused on regulatory compliance and, in some cases, simply used to confirm strategic decisions in retrospect. Since that time, corporate risk management took the opportunity to develop their role as business partners within the company. We therefore examined a cooperative approach that intensely leverages knowledge from headquarters and divisions using centralized governance, processes, and templates. Expert discussions are a key element for gathering and interpreting scanning indicators. The applied risk cockpit is in a mature state, focusing on information for the corporate CFO, other board members and, in an accessory working mode, for executives at the division level.

Company C is a manufacturer of optical systems, measuring equipment, and medical devices. The divisions have decentralized scanning systems in place, but no approach exists at group level. In summer 2011, the head of corporate BI was charged with standardizing information presentation and aggregating environmental scanning results. No attempt will be made to create a fully centralized scanning system. Instead, a BI umbrella approach supports standardized interpretation, graphical presentation, drill-through analysis, and communication of information. The environmental scanning system we researched was thus in an early stage, and had the central board as its target group.

Company D is in the chemicals and consumer products industry. The issue of a centralized environmental scanning system became evident in the 2008/2009 economic crisis. Company D distinguishes between the early detection of risks and business opportunities. While the risks are covered in a centralized and standardized approach, business opportunities are pursued by the divisions. A deterministic, quantitative approach to the evaluation of risks and opportunities is preferred over individual assessment. Environmental scanning is performed using just two to five market indicators and their associated tolerance levels. This external perspective is then compared to forecast financial indicators, such as revenue and EBIT, in three different scenarios. The results are sent to the board members to support them in performing balanced opportunity and risk management.

5.3 Cross-case results

We asked the interviewees how important it is for their environmental scanning systems to fulfill the characteristics of our evaluation criteria (to-be profile) and how they rate the environmental scanning systems they currently use (as-is profile). In both cases, they answered using a five-point scale from "1" (very low) to "5" (very high). The difference between the to-be and as-is values represent the design gap for each company. The arithmetic mean across all gaps is referred to as the mean gap (column 5). In addition, we show the mean gap without Company C, as its environmental scanning systems are not located at a business, but bundled by the BI department. Fig. 2 illustrates the results.

Incomplete information: In terms of information gathering (evaluation criteria 1-5), all companies agree that they have to increase their coverage of strategic risks (EC1) – those risks related to the company's vision and strategic program (to-be values between "3: somewhat" and "5: very high"; mean gap=1). For example, Company A focuses on risks in terms of raw materials prices, production capacities, and customer discounts, covering the market situation for the next three months. However, they do not leverage weak signals such as rumors and trends, especially "megatrends". In turn, with the exception of Company B, all participants are satisfied with their coverage of operational risks (R2, mean gap=0.38). Company D argued that it collects too much operational information (inverse evaluation, Figure 3). Information for regulatory compliance is not a central issue. All companies fulfill regulatory needs (EC3, mean gap without Company C=0.33). Company C sees potential to its level of interpretation in this area. In terms of the opportunity/risk ratio (EC4), Companies A, B, and D agreed that their IS focuses more on risks than on opportunities, and that they need to improve on this issue (mean gap without Company C=0.83). At Company A, opportunities are covered only if they relate to the business model. Because of its decentralized approach, Company C's scanning system considers opportunities in greater detail than the centralized systems at other companies do (as-is/to-be value=4).
At all companies, IS support for information gathering (EC5) is at a basic level (as-is values between "1" and "2"), but they see little need for improvement (mean gap without Company C=0.17). For example, Company D uses MS Office tools, but appears to be satisfied. In turn, Company C wants to establish an integrated BI solution with IS functionalities for gathering information.

Figure 3: Cross-case comparison of companies’ self-assessments

**Insufficient knowledge processing**: With regard to information interpretation (EC6-8), we identified different approaches to prevent bias (EC6). Company D relies on deterministic interpretation based on indicators in combination with their tolerance levels, whereas Company A interprets five information clusters, each based on an internal expert judgement, to provide users with cause-effect chains. However, most companies are satisfied with their approaches to preventing bias (mean gap=0.33). Because it uses a number of decentralized approaches, Company C did not respond to these evaluation criteria. Knowledge and thinking support (EC7) is provided either as generic cause-effect chains supporting individual assessment (Company A) or a correlation analysis of financial indicators (e.g., EBIT) that results in tolerance levels (Company D). Company B concentrates on a cooperative approach involving experts to integrate even informal information on the environment. Group risk management then synthesizes these separate aspects into a big picture. At companies other than Company B, this synthesis is not performed systematically, making integration a point for improvement (mean gap=1.25). IS support for information interpretation (EC8) is generally at a basic level (as-is values between "1" and "3") and most often leverages MS Excel functionalities or IS derives (Company B). Besides Company D, all companies agree that IS improvements are needed here (mean gap=1). Company A and B argue for additional aggregation of qualitative information within IS support.

**Limited IS-based features**: Capabilities for information usage (EC9-12) vary widely. As Company D uses MS PowerPoint for presentations, it wants a better quality of information presentation (EC9) and user interface and dialog control (EC10). The other companies see little need to improve these criteria (mean gap without Company C=0.17). Furthermore, all companies other than C see little value in communication functionalities (EC11, mean gap=0 without Company C), but all companies believe it is necessary to improve the ease of IS handling (EC12, mean gap=0.33, without Company C=1.25).
Unshaped (IS) design for use: Companies rate the timeliness (EC13) of their environmental scanning reporting from "3: somewhat" to "4: high"; reporting frequencies range from quarterly (Company B) to monthly (Company A). At Company D, analysis is performed quarterly, but board reporting takes place just once a year. Overall, the companies would view a more frequent process positively (mean gap=0.75). As most IS are based on MS Office, their flexibility (EC14) is rated "high" on average (mean gap=0). Data changes are adopted on a monthly to quarterly basis. Accuracy (EC15) earns an average score, since IS are generally focused on providing an overall impression rather than accurate information for each specific point (EC14). Existing IS already fulfill the criterion of consistency (EC16), and companies see no need for improvement in this respect (mean gap=0.25). Regarding interorganizational integration (EC17), Company B actively uses business partners for interpretation, whereas none of the others have anything comparable in place. Companies B and D even include banks to enhance the interpretation of their economic situation. All companies want to improve in this area (mean gap=0.75). Concluding with the IS transparency (EC18), Companies A and B are satisfied with the validation they currently use, whereas C and D see opportunities for improvement (mean gap=1.25). As reporting is optimized for executive use, it takes the form of a paper-based booklet with access to important topics. Leveraging more advanced IS support is seen as necessary.

Inappropriate time for IS implementation: Cost adequacy (EC19) is not an issue for environmental scanning systems we studied (mean gap=0). Time adequacy, in turn, is a problem (EC20, mean gap=0.67). At Company A, three risk management employees were involved in the IS design in parallel to their day-to-day work. At Company B, eight workers primarily designed the IS, but others were involved as well, producing an IS we considered to be sophisticated. Company C was unable to assess the effort its IS entailed since the various systems were developed directly by the divisions. Four internal sources were needed to develop Company D's environmental scanning system in six months. They considered the time needed for this setup, especially IS implementation, to be too long.

6 Discussion

After reviewing the cross-case results, we focus on synthesizing design guidelines to fill the identified gaps. Besides functional value propositions, we especially argue for the role that IS can play in environmental scanning. Designing a more comprehensive information model: In terms of information gathering, current environmental scanning systems are dominated by two concerns: focusing on operations (EC2) and fulfilling regulatory requirements (EC3). One reason is that indicators forecasting strategic issues (EC1) lack grasp in practice. All companies realized they needed a more balanced and forward-looking management of opportunities and threats (EC4). As Company B shows, the strongest lever to achieve this goal is the coordination of information gathering within and among company organizations. Thus, a first design guideline for making environmental scanning more applicable than those outlined by previous research can be outlined as follows.

Guideline 1: Companies can improve the information model for their environmental scanning systems with more balanced coverage of operational and strategic risks and – even more important – a more balanced and forward-looking management of opportunities and threats. The strongest lever to do so is intra- and interorganizational coordination of information gathering.

The interviewees stated that they have no standardized IS for information gathering (EC5). They look forward to a cockpit approach that provides an overview about cause-effect chains based on a framework of the most important scanning areas. Concrete IS capabilities can contribute, as we see at Company B. Most currently, keyword text searches could be used to scan for indicators of future events. Companies also view data mining and semantic search as helpful. In addition, we propose using neural networks to generate indicators.

Setting up a collective learning process: Within the area of information interpretation (EC6-EC8), we identified two approaches: deterministic interpretation and multi-individual heuristic interpretation. In terms of leveraging knowledge (EC7) the interviewees argued for incorporating experts. For Company B, improvements would entail operationalizing weak signals of country developments, new regu-
latory requirements, and factors influencing how consumers use technology within scenarios for company growth. In comparison to the examined body of knowledge, for example Narchal et al. (1977), which most often show just the end-products of information interpretation such as impact matrices, we propose a second design guideline to overcome personal biases.

**Guideline 2:** Environmental scanning systems should enhance a collective learning process for information interpretation. The results can be improved by including multiple opinions within the IS and enabling an active exchange of perspectives among the different participants.

Regarding the IS support, Companies A and B argue for additional aggregation of qualitative information and multidimensional navigation within the collected data. They plan to expand the range of information interpretation. Indicator maps, like those used by Company A, make it possible to quantify threats and opportunities.

**Using IS to enable management techniques familiar to executives:** Since all the evaluated scanning systems are currently based on MS Office (Companies A, C, D) or an individual application (Company B), IS capabilities for information usage are quite basic. Even though our respondents were satisfied with their information presentation, user interface, dialog control, and communication capabilities (EC 9-11), Company C provided insights about what future IS capabilities could be. For example, IS can enable more individualized use of information by bringing together various types of information presentation such as impact matrices, dashboards, and value-driver trees, with scenarios or balanced opportunity-and-risk portfolios and adding navigation functionalities such as hierarchical structures and drill-downs. Using IS to enable (standard) management techniques executives already know should increase their acceptance of IS in environmental scanning. Expanding the executive information system (EIS) scope of Frolick et al. (1997) we state as follows.

**Guideline 3:** IS-based impact matrices, dashboards, opportunity-and-threat portfolios, and value-driver trees provide multiple options for information presentation, along with modern navigation functionalities. Ideally, environmental scanning systems can adapt to executives individual working styles and responsibilities.

**Designing processes for more interorganizational integration:** Timeliness (EC13) and flexibility (EC14) are cross-process factors for environmental scanning systems that often require a tradeoff. In all cases, companies are clearly aspiring towards monthly reporting of external information and, often, daily reporting for internal information, without reducing the flexibility of the IS to adapt to changing requirements. Closely related to information gathering is the degree of interorganizational integration in environmental scanning (EC17). Company B’s integration of external partners into their scanning process suggests that this is an interesting avenue for increasing scanning efficiency.

**Guideline 4:** Environmental scanning systems could act as a company's business network, and, thus, become a multidirectional AIS platform for insights on future developments. IS should cover information consolidation, correlation analyses, and scenario development.

**Accelerating prototyping:** In terms of effort, time adequacy (EC20) is a final issue in environmental scanning system design. IS prototypes are sometimes first available after half a year of development, lowering support from business side. Prototyping is a technique to accelerate IS development. In particular, portfolio and dashboard applications should help to reduce implementation effort. Since they are available in vendor portfolios, they can be integrated into overarching AIS architectures.

**Guideline 5:** IS engineers should accelerate prototyping when designing environmental scanning systems to provide users with a "look and feel" early in the project. Clickable versions stimulate feedback from the business side and, in the long run, increase users’ acceptance of IS.

7 Conclusion and Future Research

The objective of this paper was to develop design guidelines for environmental scanning systems that are more applicable than those outlined in previous research. In doing so, we compiled a set of requirements based on the principle of economic efficiency. Then we drew on findings from the absorptive
capacity theory to specify them. Our research entailed a multicase study that challenged existing im-
plementations against these requirements. We synthesized the findings into design guidelines.

These guidelines should serve as predefined ways to redesign existing environmental scanning systems or to bring a new generation to life. As a result, this article does not include a substantial evaluation of these guidelines or the subsequent design of new-generation environmental scanning systems itself. Other limitations on hand indicate avenues of future research as well. For example, case studies, due to their nature, do not lead to a strong understanding of how often phenomena occur in the total population. Thus, a next design cycle should include a broader analysis. To “create a better world,” this research should emphasize concrete design principles for environmental scanning systems in contrast to the "pure" requirements identification we most often found in our literature review.

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