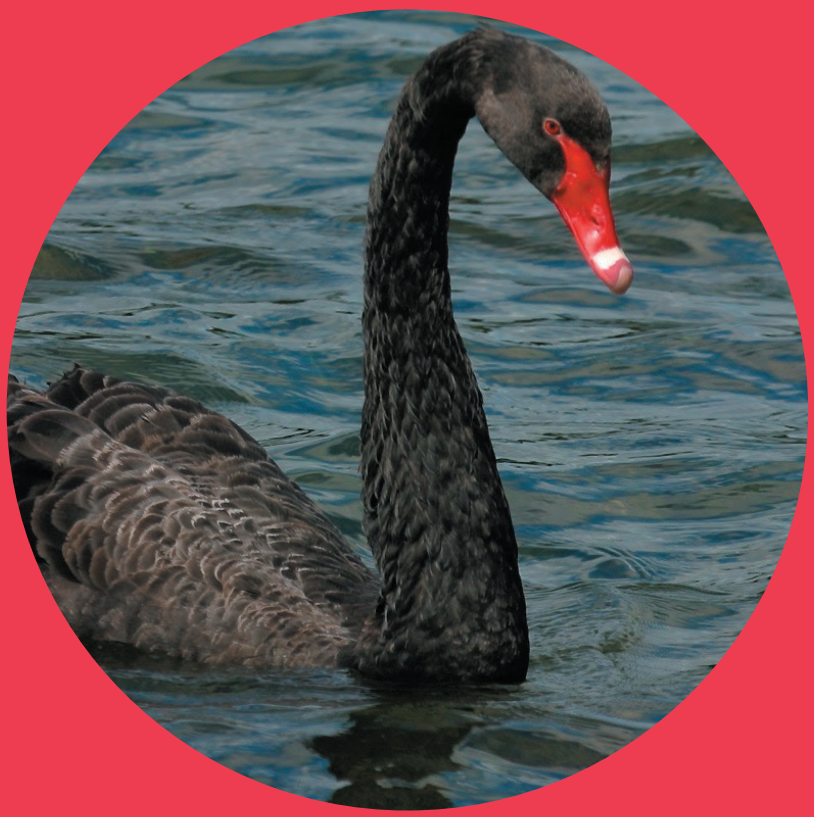
Department of Industrial Engineering and Management

Increasing Flexibility by Environment Scanning of the Early Signs of Change in the Complex Environment

Leena Ilmola-Sheppard



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Increasing Flexibility by Environment Scanning of the Early Signs of Change in the Complex Environment

Leena Ilmola-Sheppard

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Abstract

The new and distinctive features of the environment at the end of the century will be increasing in volatility with a growing number of climate-related extreme events and increasing uncertainty. The global economic system will be characterized by complex interdependencies. Traditional strategy building and foresight have developed means for anticipation, but in this challenging environment there is a need for additional means of increasing the flexibility of organizations.

This thesis explores the horizon scanning and information acquisition process as a means for increasing organizations' readiness for change. The aim of the study is to propose a theory based construct of information filters for environment scanning and to describe the impact of the filter on outcomes of the horizon scanning process.

The study was conducted by combining grounded theory methodology with case study designs. The four case studies were analyzed in order to collect an in-depth understanding of the filtering impact within various filter settings.

The thesis contributes to current theoretical and practical understanding in horizon scanning and anticipative strategy building in two ways. First the study developed the existing information filter theories further so that the extended theory presented includes the requirements of the complexity of the environment in the filtering process. Second the study summarized the theoretical understanding into a pragmatic filter construct that is easy to modify according to the needs of the strategy process.

Keywords weak signals, strategy, complexity

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Tekijä
Leena Ilmola-Sheppard

Väitöskirjan nimi
Heikkojen signaalien seuranta joustavuuden lisäämiskeinona kompleksissa toimintaympäristössä.

Julkaisija Perustieteiden korkeakoulu

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Tiivistelmä

Lisääntyvä syklisyys ja nopeat volyymivaihtelut nousevat globaalin toimintaympäristön tyypillisiksi piirteiksi lähes kaikilla toimialoilla vuosisadan loppuun mennessä. Ilmaston muutos johtaa säiden ääri-ilmiöiden lisääntymiseen ja poliittisen ilmapiirin muutokset nekin lisäävät epävarmuutta. Monimutkaiset keskinäiset riippuvuudet leimaavat maailmantalouden kehitystä. Perinteinen strateginen suunnittelu ja ennakointi käyttävät erilaisia keinoja epävarmuuden hallintaan, mutta tässä haastavassa ympäristössä organisaatioiden on kehitettävä ja otettava käyttöön uusia menetelmiä, jotka lisäävät organisaatioiden muutosjoustavuutta ja reagointinopeutta.

Tässä väitöskirjatutkimuksessa tutkitaan toimintaympäristön seuranta- ja tiedonhankintaprosessia yhtenä mahdollisena keinona organisaation muutosvalmiuden kehittämiseksi. Tutkimuksen tavoitteena on luoda teoriaan perustuva rakenne, joka auttaa ymmärtämään toimintaympäristön seurannassa käytettyjen menetelmien suodatinominaisuuksia ja niiden vaikutusta lopputulokseen.

Tutkimusmenetelma on tapaustutkimus, jonka tuottaman tiedon avulla luodaan oletus konstruktion tietosuodatinten toiminnasta. Neljässä tapaustutkimuksessa analysoitiin erilaisia strategiseen suunnitteluun tietoa tuottavia seurantamenetelmiä, joissa käytettiin erilaisia suodatinasetuksia.

Tehty tutkimus lisää sekä teoreettista että käytännön tietoa, joka auttaa johtamaan toiminta-ympäristön seurantaa ja ennakoivaa strategiaprosessia kahdella tavalla. Ensinnäkin tutkimus kehitti olemassaolevia suodatinteorioita eteenpäin niin, että syntynyt laajennettu suodatinteoria soveltuu aiempia paremmin kompleksisen toimintaympäristän vaatimusten mukaiseen varhaisten muutosten seurantaan ja strategiseen suunnitteluun. Toiseksi tutkimus esitti teoriaan pohjautuvan käytännöllisen suodatinkonstruktion, joka on helposti muunneltavissa kulloisenkin strategiaprosessin tarpeiden mukaisesti.

Avainsanat heikkojen signaalien kartoittaminen, yritysstrategia, kompleksiuus, joustavuus

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This kind of work is not possible without good case data. My inspiring partners in this exploration have been Matti Kalervo, Markus Nordberg, Harri Turpeinen and Howard Weinberg. You have shared with me the critical data – and you were willing to pilot novel methods with your organizations.

At the early phase of my research process I had the good fortune to be supervised by Professor Erkko Autio, who steered me in the right direction. Eero Eloranta, my last supervising professor, challenged me to work - against my true nature - with details that are essential for a certain quality of research. Perhaps I have not shown my gratitude during the process, but I'd like to do so now. I cannot thank enough my advisor, Dr. Osmo Kuusi, who walked me through the process. The long discussions we had have brought me and my dissertation exactly to this point. This process would not have been possible without the ever patient and inspiring supervision of Dr. Osmo Kuusi.

My dear friend Dr. Victor Vurpillat has spent numerous hours in improving my non-existent English grammar, and helped me to reword not so comprehensible thoughts into a clearer format.

I want to dedicate this work to two important men of my life. To my father, who taught me that if you have a goal, and if you are willing to work hard, you will reach your goal. It may not happen in the way that you planned, or in the desired time frame. Dearest Father, it took 14 years - about three times longer I planned - but I have completed the task. First and foremost of all of these important people I want to thank, is my darling John, who has supported me during these years of work. He is my rock, he is my harbor.

Contents

The dissertation consists of following publications:

Ilmola, L., Aaltonen M., and Autio E.. "Weak signal filters in vision building processes." *Annual International Conference of the Strategic Management Society*. Vol. 22. 2002.
Appendix 3

Ilmola L. and A. Kotsalo-Mustonen (2003) Filters in the strategy formulation process, Journal of Universal Computer Science, vol. 9, no 6 (2003), 481-490
Appendix 4

Ilmola L. and Nordberg M. (2004) The role and dynamics of schemata in strategic sensemaking process, *Annual International Conference of the Strategic Management Societ*y Vol. 24 2004
Appendix 5

Ilmola L. and Kuusi O. (2006) Filters of weak signals hinder foresight: Monitoring weak signals efficiently in corporate decision-making *Futures, Volume 38, Issue 8*, October 2006, Pages 908–924
Appendix 6

Ilmola. L. and Kuusi O. Information filters as one of the means of managing strategic fit in a complex environment, *Foresight 2* Volume 15 issue 2, March 2013 Pages. 132 – 151
Appendix 7

Contribution comment: In all of the published papers Leena Ilmola has been responsible for data collection, data analysis and theoretical elaboration. The co-authors have contributed to the writing process and the formulation of the final conclusions.

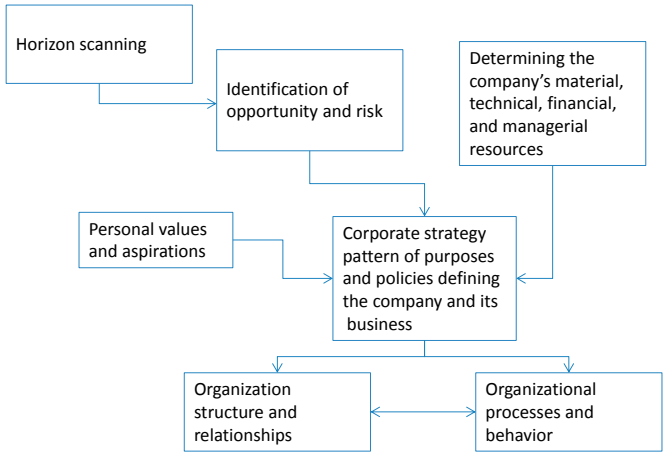
We can get no nearer to reality than the mental representation we make of it.
Peter Checkland 1985

I Introduction to the research theme

Organizations, in order to be successful in an environment dominated by fast changes, need to increase strategic flexibility, speed of reaction and anticipation of surprises (Casti 2012, Makaridakis and Taleb 2009, Mendonca 2009, OECD 2011, Sanchez 2002). In this research summary that is based on three published articles and two conference papers (please find detailed published papers in appendices 3-7) I will describe the emerging need for a new type of horizon scanning as a part of the corporate strategy process. First I will elaborate these new emerging requirements of flexibility, and then I will define the key concepts of this study and at the end of this chapter I will explain overall research approach and key results of the empirical studies (presented in detail in appendices 3 and 5-7).

1.1. New requirements

The need to support strategic decision making by efficient environment scanning and early detection of signs of change is not new, Igor Ansoff presented the idea first time already in 1965. The motivation for this study comes from the fact that the strategy process has to anticipate changes in the market in order to adapt as fast as possible (Beer 1985, Casti 2012, OECD 2011). Thus, environment scanning has increasing importance due to the increasing complexity of the environment (mm. Henderson et al. 1990).



Picture 1: Strategy process modified from de Wit B. and Meyer R. (1994) p 44.

The business environment develops unpredictably, which makes strategic planning and decision making a challenge (Ackoff 2006, D'Aveni1994). The list of factors causing uncertainty is a long one: growing interdependencies of the globalized market place, new types of systemic risks (OECD 2011) that emerge from heightened mobility of resources, interdependencies of production and delivery systems, centralization of production and financial systems and concentration of population and assets. Decision makers have, in this situation, two different strategies: either try to collect as much information as possible in order to reduce uncertainty (that is, to use the horizon scanning systems for anticipation) or give up the idea of knowing and focus on building the organization as resilient as possible (Daft and Weick 1984). Igor Ansoff launched the concept of weak signals and early strategic actions as a source of competitive advantage. Now, almost 50 years later, it seems that the horizon scanning is a basic prerequisite for survival (Futures Vol 44 2012 and the theme number of Long Range Planning Vol. 35 2004) in the new complex environment.

Organizations that are quick to detect changes and are resilient enough to adjust will be the ones that succeed in the complex turbulent environment (Ackoff 2006). This is not easy, because organizations have a tendency to rely on their existing perception of the environment, and new phenomena that do not fit this perception are filtered from the scanning results (Weick 1995, Kaivo-oja 2012). I refer to this feature as information filters.

The unit of analysis of the research presented in this dissertation is the organization. I will focus in this paper on the early phase of the corporate strategy process: the environment-scanning process of knowledge-intensive organizations operating in a turbulent environment. In order to study this, I use the cognitive diversity of the mental model as a unit of observation when collecting information of filters that have an impact on the result of the scanning process.

Our research questions are:

1. What is the needed structure of the information filter used in the environment scanning process?
2. What is the impact of different filters with different width and depth on the outcome of the environment scanning process?

I will return to these questions in details after I have described the research gap that this study will address.

1.2. Key concepts used in this study

Key concepts of this emerge from the scope; strategy process and its information requirements.

Strategy process is considered to cover both data collection, analysis and designing strategic choices and making decisions on actions required. By an environmentally sensitive, anticipatory (Ansoff 1979) strategy process, I mean strategic planning process that uses foresight as one of the inputs. (Aguilar 1967, Anderson 1995, Hamel et al 1999, Hendry 2000, Minzberg 1994 and 1995).

Due the nature of the strategy process, the research unit of this study is *an organization*. I am studying one part of the organization's strategy process, the environment scanning process and the formation of a shared perception. I will focus on the information intake of knowledge-intensive organizations.

By *knowledge intensive organizations,* we mean organizations where the raw material of the production process is information, the majority of the added value is generated by processing information and the outcome, products or services are based on knowledge. (Sveiby 1986)[1] From a management perspective, it is crucial to understand how to add versatility and destabilize an organization by adjusting information flows to the organization.[2]

Information acquisition in this study will be called *scanning*. Horizon scanning and environment scanning (used as synonyms in this study) refer to a collection of early change data, often called

[1] A knowledge-intensive organization is an organization where the majority of the employees are highly educated, where the "production" does not consist of goods or services but complex non-standardized problem-solving. According to McDaniel (1997) the four main distinguishing features of the production are non-standardization, creativity, high dependence on individuals, complex problem-solving.

[2] Same applies to opposite task, stabilization of the organization. From now on I will focus on destabilization until at the end of the study I return to the stabilization.

weak signals of change (Aguilar 1967, Ansoff 1983 and1990, please also see a review of Weak Signals especially number of Futures 2012 Vol 44).

Information filters are those filters that select the information that is going to be used in the decision making (or planning) process. Information filters consist of all the explicit rules, methods and procedures used for data acquisition, distribution and interpretation – and finally the analysis of the data acquired from the selected data channels (Beer 1985). The *sensemaking process* in this study includes both explicit and implicit mental processes of scanning, framing, interpreting and constructing a conception of the situation at hand (Weick 1979, 1995, 2001).

The Environment is *turbulent*. If the environment is simultaneously undergoing an accelerating rate of change and becoming more complex it will be turbulent and virtually impossible to predict (Day and Schoemaker 2004, Emery and Trist 1965, Ackoff 1974 p. 4.).

For *complexity,* this study follows the definition of Anderson and McDaniel (1997, 1999), and Ackoff [3](1974). When I am speaking about complexity, I am referring to systems, where agents (people/organizations) are interacting with each other, and their behavior is defined by a high number of feedback loops of the interaction. The system is complex if the interaction rules are not deterministic and the behavior of agents is producing emergent behavior in the system level (Ackoff 1974 and 2006, Anderson 1999, Johnson 2008).

[3] According to Anderson and McDaniel Complex adaptive systems (CASs) include a number of agents or features that are interacting locally in a dynamic and nonlinear way. These interactions have multiple feedback loops so that system history matters. New patterns are partly functions of what went on before. Agents operate under set of rules that change over time as they gain experience through interaction with the environment and each other. The interesting challenge for the study of complexity is how order emerges from the interactions among agents. (Anderson and McDaniel 1999, p. 119)

In this study, I will apply Luhmann's (Luhmann 1995 p. 30) *organization as a social system*, and his discourse that everything outside of its boundaries is its environment. This environment consists of a network of systems that may or may not have an impact on the system studied. When the system is differentiated into smaller functional or otherwise specified parts, organizations, they are called sub-systems.

Cognitive structure plays a key role in information filters (Hodkingson 2003). Cognitive structure consists of *mental models* (a mental model is an outcome of the sensemaking process; it describes how things work, what is important, and what is not important). In the Complex Adaptive Systems theory, a set of mental models is called as *schemata*. Schemata consist of internal rules of collaboration and a perception of external rules of co-existence with other systems. Schemata determine the actions of an agent (an organization) (Anderson 1999). (More detailed description of schemata in appendix 5, page 4.)

1. 3. Focus of this study, research methodology and report structure

The management challenge–flexibility in a complex environment–described in chapter 1.1. is twofold: First, how to detect new, still weak signs of change when an organization as a social system is tuned for the opposite i.e. for seeking confirmation of its existing perceptions (Luhmann 1995). Second, how to make sense of them and control those natural filters that all social systems use when processing new information (Aguilar 1967).

Research methodology

The research method chosen for this study is a comparative qualitative case study method that tests a theory based construction in several organizations.

I perceive the challenge described above as theoretical by its nature, and the tentative extended filter theory presented in this study aims to enlighten this issue. The theoretical part of the study consists of a literature study that briefly covers the current theories of strategic decision making, collects deeper insight on theories about information filters in the scanning and sensemaking process and then assesses their feasibility in the complex environment. At the end of the chapter, I describe the missing elements by defining some additional features that have a strong impact on the outcome of the scanning process (Aguilar 1967, McKelvey 1999 p. 15, Suppe 1977). The conclusions based on existing theory have been described in nine insights that are the cornerstones for "an extended filter theory".

In order to meet the second of the challenges, I first run comparative empirical case studies. The extended filter theory has been operationalized in two ways. For testing purposes, the theoretical understanding has been the basis for specifications of the web-toolset (described and defined in detail in appendix 2) that has been used for data collection. Second I tested the insights of the extended filter theory in a controlled comparative setting, in four case organizations, all together in ten different strategic scanning processes. The scanning processes of case studies are differentiated by using different filter settings of both the data collection tool and the process phases, thus results provide a response for the second research question

For hypothesis testing in the case studies, I applied both inductive and deductive reasoning. The theory driven propositions were deductive by their nature, but the analysis of each of the cases also produced some inductive propositions to the next case study. Case studies were conducted one after another, and due to the complementary nature they did not apply exactly the same research layout. Case studies are reported in detail in published papers and referee process passed conference papers. The first case, the international technology company (Case ITC) described the idea of information filters and their role in the strategic visioning process. The key finding of this case study was to define the key dimensions of the information filters. The results were presented in the Strategic Management Society Conference 2002 (appendix 3). Further theoretical elaboration of information filters in the strategy process was described in the paper published in the iKnow conference and then in the Journal of Universal Computer Science (appendix 4). Both the theoretical elaboration and the dimensions of the filter construct were used in the next case study, a study of an international research organization (Case IRO) that compared different filter settings in two different risk assessment processes. The results were reported in the Strategic Management Society Conference 2004 (appendix 5). The third case study about the horizon scanning process of a global energy company (Case GEC) was published in the Futures Journal and focused on the impact of different sensemaking processes (appendix 6). The fourth case study looked at the horizon scanning process of a global consulting company (Case GCC). The study focused on the investigation of complexity related filter features; especially the interaction between the organization and the scanned environment. The outcome of the Case GCC analysis was published in the Foresight Journal (appendix 7).

This research contains some inbuilt value. First, all of the cases provide rare access to a very sensitive process of strategic planning in organizations that are operating globally. The information

collected and also the conclusions represent the very core of the confidential data used in the strategic decision making. This provided a valuable opportunity to access data for studying strategic flexibility and strategic thinking. Second, the pragmatic applications of the Complex Adaptive Systems theory are so far quite rare (Ackoff 2006). Third, the method used for collecting data and reporting it is relatively free from interpretation by the researcher. Unlike in interview or observation methods, the research layout–due to the standardized information collection and analysis method–is easy to reproduce. The automatic reporting method also facilitates objective comparison of different organizations and cognitive structures of their strategic planning.

II An Extension to the Current Filter Theory

The primary goal of horizon scanning is to produce information for decision making within the strategy process. In this chapter, I will first look briefly at the literature of strategic planning and related decision making. In order to justify the need for the study, I will review as well the key fundamentals of environment scanning presented by Ansoff and also the approaches of the most recent publications within the field. As an outcome of the analysis, I will present the research gap and the final research questions of this study. The research questions defined will require additional theory building; thus I will present some theory based insights that lead to tentative extensions to the existing filter theory. These theory based insights will be used for the constructive purpose of structuring information scanning filters.

2.1. Strategic planning and decision making

Information used in the strategic decision making process is defined by the perception of the business environment and its nature (table 1). Different strategy schools (d'Aveni 1995, Brown and Eisenhardt 1998, Doz and Kosonen 2008, Hamel 1999, Handy 1976, Hendry 2000, Minzberg 1995, Porter 1995 and 2011, Reynor 2007, Sanchez 2008) are children of their era and presumptions on environment reflect the nature of the business environment at the time when they were designed. Sensemaking and decision making is centralized. Even if the increasing requirements for participatory planning processes information have been recognized already in the 80's and 90's (please see Hendry 2000), ideas of decentralized systems have had a minor impact on the nature of strategic planning approaches.

	Strategic environment	**Strategy approach**	**Perception of the operating environment and data used**	**Typical features of decision making**
STABLE	Environment is perceived as *stable* and relatively predictable with known causalities	*Traditional:* Linear, analytical process (Andrews, Ansoff, Porter).	Past performance statistics, trends, exploitation of data, reductionist measures, focus on quantitative analysis, excel.	Centralized decision making with clear pre-defined rules.
DYNAMIC	Operating environment is seen *as dynamic, but* still in some extent predictable, but complicated.	Adaptive: competitive actions and learning approaches. (D'Aveni, Hamel, Quinn, Minzberg, Senge).	Past performance analysis for defining constraints, sensemaking based on competitors (market) reactions.	Fast sensemaking essential, short stimulus-action time. Decision making and sensemaking centralized.
COMPLEX	The *complex* operating environment is not predictable; it contains fast feedback loops and results in disruptive changes in the markets.	*Cognitive*: Strategy takes its meaning from the social context in which it evolves. (Brown and Eisenhardt, Hendry, Larcche , Weick).	Perception of the environment and its changes is a social construction; information collected in social interaction with the environment and made sense within an organization.	Decision making is centralized, but related data acquisition and sensemaking are decentralized "into minds of people"

Table 1: Different strategy approaches, their perception of environment analysis and decision making. Andrews 1995, d'Aveni 1995 , Brown and Eisenhardt 1998, Hamel 2007, Handy 1976, Hendry 2000, Minzberg 1995, Porter 1995, 2001, Quinn 1995, Senge P.M. 1990, Senge et al.1999).

The focus of this study is in the horizon scanning; thus I have only summarized the primary strategy schools in the table (arranged by Snowden's taxonomy of different environments, Snowden and Boone 2007) above. The table indicates that even if the cognitive school (Weick 2001) meets the environment scanning challenges better than the traditional or adaptive strategy approaches, there are some potential handicaps in the planning design from a complexity perspective. The

comparison in the table above shows that all of the approaches share the central role of the management as the sense and decision maker. When complexity of the environment is increasing, centralized scanning, sensemaking and decision making procedures are simply too slow, and they generate rigidities that prevent an organization from reacting quickly to a changing environment full of diverse information (Anderson 1999, Ashmos et al. 2000, Henderson et al. 1990).

2.2. Three missing elements of traditional scanning literature

The complex environment is a specific environment. The requirements for both the strategy process and horizon scanning process are somewhat different in a complex environment from those for a stable environment. A literature review revealed that there are at least three research gaps that require some additional theoretical consideration:

1) Linear nature of scanning process
2) Managerial centrality
3) Insufficient understanding of requirements of complexity

Let us start with challenges of the linear approach. Igor Ansoff is a typical representative of the *linear thinking* (please see the revealing example Ansoff 1979 p. 183), but paradoxically he was simultaneously one of the pioneers (Rossel 2011) to consider the impact of complexity of the operating environment to organizations. Ansoff created a whole linear construction for the entire strategic planning process (Ansoff 1979 pp 1-7) that also included the interaction with the environment.

Strategy's main purpose is (Ansoff 1984 p xvi) to position the firm into its environment, and change internal configurations and dynamics of the organization (Ansoff 1979 p.5) as a real time response to the change. The key issue for Ansoff was the organization's capability to adapt to the environment. An effective adaptation (Ansoff 1984 p. 326) requires a clear perception of the changes, both prospects and threats, in the firm's environment. This clear perception is needed in order to minimize the delays of response to new major threats and opportunities. When the environment is complex the organization is forced (Ansoff 1979 p. 53) to start their response at a progressively earlier state of knowledge. The time available for reaction becomes shorter and simultaneously the most complex organization requires more time for effective response. In order to fulfill these requirements an organization has to identify weak signals of change (either opportunities or threats) as early as possible; an organization has to scan the environment (Ansoff 1979 p. 144).

Ansoff is in many respects a forerunner (Ansoff 1965,1979 and 1984, Aguilar 1967, Kaivo-oja et al. 2011, Rossel 2012) and even a visionary when he saw anticipation as one of the sources of competitive advantage, but in one respect he is the representative of his era (as well as Aguilar 1967, Auster and Choo 1998 and Beer 1972, 1985). His approach is very management- or even *manager-centered*. Ansoff describes in 1984 (p. 27) Ashby's principle of requisite variety; complexity and speed of the firm's response must match the complexity and the speed of the environmental challenges, but he does not apply the complexity requirement mentioned to the decision-making setting. The strong focus on leadership leads him to exclude the opportunity to increase the complexity of the organization by increase of participation (Ashmos et al. 2000, McDaniel 1997). He even claims the total opposite: that distributed power creates inflexible adaptation to the change (Ansoff 1984 p.213, see also Miller et al. 1998). Please find a more

comprehensive description of Ansoff's work in appendix 5, pp 4-6. and elaboration of participation in appendix 3 p.7.

Management centricity has been challenged in recent scanning literature. Saritas (2012) has integrated a participatory dialogue that uses both qualitative and quantitative scanning data into the foresight process. Palomino et al. (2012.) present a comprehensive, analytical horizon scanning system, and Könnölä (Könnölä et al. 2005) adds quantitative portfolio modelling to the selection of participatory analytical methods. The value of participation has been identified, but the nature of the participation as a methodological dimension (Ashmos et al. 2000) is not described in full depth (Aguilar 1967, Kaivo-oja 2012, Miller et al. 2012).

Ansoff's work provides a platform also for a very different trajectory of development. Ansoff saw the meaning of creation already as an important mental process for an organization (Ansoff 1984), but especially Karl Weick's sensemaking theory (Weick 1979, 1985) had direct roots in social constructionism (Berger and Luckmann 1966, Chia 1994). If the reality is a social construction, the scanning process can be seen as an intersubjective process of meaning creation and weak signals are context dependent social constructs of reality (Cunha 2012, Dennis et al. 2011, Joergensen 2012, Stacey 1995, 2000, 2001). Cunha has extended the idea towards improvisation; Joergensen adds design perspective (structure and interaction), and Stacey integrates the knowledge theory aspect into a sensemaking and scanning system. These theorists consider the scanning processes as a distributed processes, but one element is still missing; they speak about complexity (Miller et al. 2012), but seem not to apply it as an additional perspective to the nature of the scanning process.

Thus the third missing perspective is a systems approach (Miller et a. 2012, Stacey 2001, Luhman 1995). Stafford Beer (1972, 1985) made a pioneer works as a systems thinker, but his theoretical

framework was cybernetics, thus his concepts were based on closed systems, that were seeking for homeostasis. Both Miller et al. (2012) and Saritas (2012) identified the need for a systems approach, but system theoretic features such as fast feedback loops, ways to find optimal fit with the environment and the self-organizing nature of the complex systems (Anderson 1999, Anderson and McDaniel 1999, Ashmos et al.2000, Forrest 2009, Stacey 2001) are not discussed.

The literature reviewed in previous paragraphs support the three research gaps mentioned at the beginning of the chapter. In order to fill the gaps, we have to generate a new understanding of two challenges to horizon scanning that are mentioned more or less explicitly in *all* of the reviewed literature. The purpose of horizon scanning and information collection is to make required changes into the corporate strategy as early as possible (Ansoff 1979). Thus environment scanning should meet following requirements

1) In order to capture early and weak signs of change the scanning system should collect a diverse set of ambiguous signs of potential change (Ansoff has created a taxonomy for this purpose, see Ansoff -84, Figure 5.4.1, p. 353). The complexity of the environment is an increasing requirement of diversity (Harris and Zeisler 2002).

2) When the captured signals are early and weak, the meaning of the signal and its potential implications are ambiguous and hidden (Godet 1984). A meaningful perception of a signals' potential implications should be developed – or amplified as Beer (1985) and Harris & Zeisler (2002) say – in a sensemaking process. The environment scanning process should include a strong sensemaking process that builds up an organization wide understanding of the change of the environment and its implications on the organizations' strategy.

The challenge of horizon scanning is emerging from controversy of these objectives; we have to strive for ambiguity (Ansoff ops. cite) and well developed meanings (Weick 1978, 1985) at same time.

In this study, the additional theory building uses this dichotomy as the starting point. In order to maintain both of the environment scanning objectives explicitly, I call[4] The first feature–the aim to collect large number of diverse potential signs of change–the *width* of the environment scanning process (read more on appendix 5, pp 6 -8 and appendix 6 pp. 3-4). The meaning of the generation capability of the environment scanning process is called the *depth* of the information filters.[5]

The research gap presented earlier, and the requirements for the environment scanning stated above providing a concrete framework for the research questions described in chapter 1.1. :

3. What is the structure of the information filter used in the environment scanning process?
4. What is the impact of filters of different width and depth on the outcome of the environment scanning process?

I shall elaborate the nature of information filters, in particular the width and depth concepts with the objective to specify the characteristics and structure of the filters required in the scanning phase

[4] Please note that in the very first case study the terms used to describe the structure of information filter were "scope" and "process" dimensions. The results of the first case study (appendix 3 p.10, visualization p. 11) led to the clarification of terms.

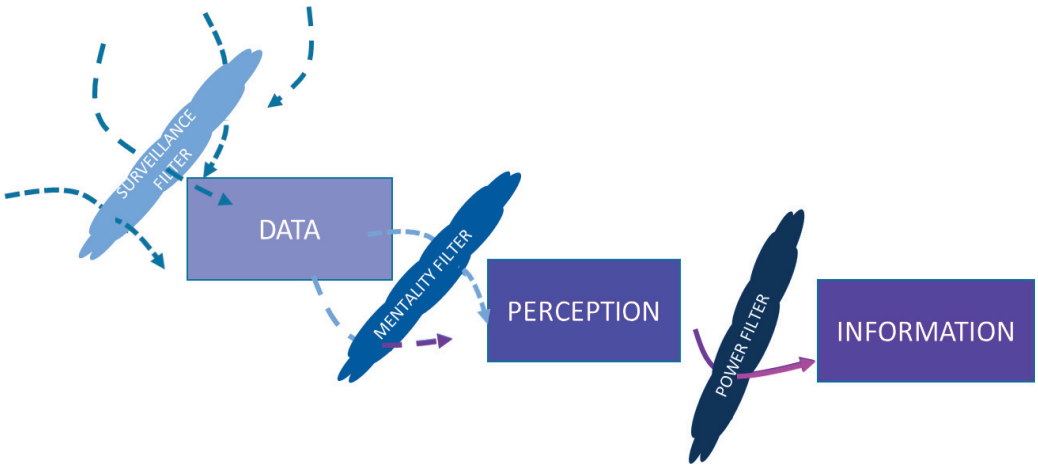
[5] Please note that these dimensions are not the only ways to perceive filtering; just to name some alternative approaches, we could/should also study the effectiveness of the scanning process by tracking the outcome (set of individual signals) of scanning and its direct impact on corporate strategies and their implementation. Another potential perspective could be capability building in time; how organization is changing methods dynamically from phase to phase in order to capture better material.

of the strategy process, in chapter 2.3. The definitions of the concepts width and depth will be introduced in chapter 2.4.

2.3. Theoretical bases for the filter construct

Environment scanning is an optimization challenge (Ackoff 2006, Floyd 2008). The environment scanning process should detect the early signs of essential changes in the market, and at the same time management has a need of minimization of the use of resources (Kaivo-oja 2012). The key question here from a management perspective is, how to manage this process? The proposition for the information filter theory I present in this study addresses this question by defining a filter structure. In order to reveal the theoretical background of the structural choices presented later I will review the current literature and summarize the key findings as insights that are relevant for the information filtering process and the filter's structure. I will arrange my theoretical elaboration according to the phases of the linear horizon scanning process as defined in Ansoff 1984, figure 5.2.3. As we know the process as such is not linear at all, but this is the way scanning is still organized in real life, as a linear process of sequences (http://hsctoolkit.bis.gov.uk/).

Ansoff (1979, 1984) describes information filters as a set of three successive phases in a linear sensemaking process. When a signal of change is detected, it first passes through the surveillance filter and then through the mentality filter. The third and the last filter used in a sensemaking process is the power filter. Both the surveillance and the mentality filters are usually activated (depending on the information collection methods applied) during the information collection phase.



Picture 2. Filters named by Ansoff 1984 p. 510

The questions relevant to the scan design in the Ansoffian framework are: What is the focus of the scan, and how shall we do it? How should we process the information in order to distinguish data that is important for our organization? I will add a third, more complexity focused question that goes beyond the Ansoffian scanning process. The question addressed at the end of the chapter is: What are demands of horizon scanning in the complex environment?

2.3.1. What is the focus of the scan and how is it accomplished?

The ultimate goal for early detection of weak signs of change is to win an organization some time for appropriate actions (Ansoff 1965, 1979, 1984, 1990). Ansoff's surveillance filter[6] focuses on the filtering impact of the surveillance methods, and the choices done when the scanning process

[6] Ansoff's taxonomy was not very clear here, he had several different names for various set of filters (1965, 1979) in this study I will use the classifications of the Strategic Management book (Ansoff 1984 figure 5.2.3); where he

has been designed. At the time of Ansoff, (please see Auguillar 1967 as well) the information collection focused on management actions. A more modern horizon scanning process consists of various choices related to methods and compilation of the participating groups. The design is deducted from the focus of the scan.

Ansoff saw environment scanning as an input for the strategy process (strategy building was his primary interest and weak signals detection only a side plot). I share the same focus, but unlike Ansoff (Ansoff, 1979, 1984), I will consider the filtering impact of the horizon scanning focus, as well. The scanning scope is defined by the objectives of the scan and the briefing of the scanning task. An open task description produces heterogeneous output, whereas precise, brief and clear evaluation criteria produce less diversity in the scanning process (Anderson & McDaniel 1999, Ansoff 1990, and 1995, McCaskey 1982, Rossel 2011, Tenbrunsel et al. 1996, Weick 2001).

The task description (framing) of the scanning process may generate other kinds of biases, as well. An example of a very specific surveillance filter is that used in risk analysis. A strong sense of threat is a major obstacle in the sensemaking process (Baumeister 1995, Godet 1987, Minzberg 1995, Phelps et al.2001, Tenbrunsel et al. 1996, Weick 2001). Cilliers (2000) says framing does not define only the borders of the observed field, but also the position of the observer, such as the perception of analyzability of the environment (Daft and Weick 1984). (Please read more about this phenomenon in appendix 3, pp4-7.)

If the environment is seen as impossible to analyze, then the organization is relying on the current understanding of decision makers. If the environment is analyzable, then the organization can either analyze the current (market) data or invest in anticipatory environment scanning. In principle, the scanning method can have a very narrow scope (to ask specific questions from the key clients) or to scan the whole web sphere automatically and follow up the frequency of concepts in order to

distinguish new and unforeseen developments in the marketplace. In either case, the way the task is defined will have a major impact on the outcome and the information collected (Aguilar 1967).

- *Theory based insight A: Task description of the horizon scanning process will have an impact on the cognitive filters used.*

Aguilar (1967) divided "modes of scanning" into undirected viewing, conditioned viewing and informal and formal search. When we are speaking about horizon scanning, we focus on the last of the modes in a formal search. This is justified by the fact that in order to manage the process, it has to be a conscious act of the organization, and an action (Carniawska 1997, Checkland 1994, Kauffman 1995, Osborne et al. 2001, Weick 1979, 1995, 2001) is a pre-requisite for meaning creation.

Modern environment scanning methods can be divided into two major groups; automatic web mining based methods, where data is collected by predefined search profile, and participatory scanning methods, where invited individuals process the external information into signs of change (Loveridge and Street 2005, Saritas 2012). In this study, I will focus on the latter method.

Participation and participants have a strong impact on the material collected. The mental models of the participants direct both the attention and the reference points in a scanning process (Ericson 2001, Weick 2001). In general, a person distinguishes only those signals that already are a part of our existing cognitive structure. The cue that does not fit or have a place in the cognitive structure is meaningless (Abelson 1976, Bogner & Barr 2000, Dennis et. al, 2011, Ericson 2001, Forrest 2009, Fiske & Taylor 1991, Gioia 1986, Gioia and Poole 1984, Luhmann 1995, Metznewr-Szigeth 2009).

- *Theory based insight B: Participants' cognitive structures play a role in the selection of early signs of change.*

An organization is a social system and as a social system its main purpose is to build up and maintain a distinctive identity (Berger and Luckmann 1966, Castellani 2009, Luhmann 1995). It is evident that both organizational and individual identity have a major impact on the mental model construct and on whether or not signals are accepted for the sensemaking process (Luhmann 1995, Weick 2001). The filtering impact comes from the internal redefinition of an organization's identity that focuses on eliminating internal differences. The cue capturing process focuses on supporting information that is capable of increasing internal cohesion (Arthur 2009, Beer 1985, Hollingsworth 2009, Luhmann 1995, Mendoza et. Al.2009 see also Könnölä 2011).

The shared perception of roles is one way to stabilize the organization and to channel expectations so that internal confusion is minimized. Role influences the observational focus of a person or organization, and roles provide us with information of the interpretation criteria applied (Berger & Luckmann 1966, Checkland 1994, Kar & Kar 2002).

- *Theory based insight C: Participant's role and individual and organizational identity have an impact on signals' selection.*

In this study, I divided participatory methods into two clusters: face to face interaction and web-based signals detection and processing methods. Web-based methods have a different impact on the filtering process depending on their anonymity. Anonymity is an essential feature, because the identity of the participant will play its own role in scanning for early signs of change. Individuals tend to seek confirmation of their status and avoid risking their position by presenting ideas that do not fit the dominant perception. That is the source of power of anonymous scanning methods;

anonymity (Turoff 1975, Hiltz and Turoff 1994) facilitates diversity in information collection (more about background in the Case ITC description, page 12).

- *Theory based insight D: Method's anonymity has an impact on social filters used in scanning process.*

The collected four insights describe features that have an impact on the focus of the scan and thus its output. After the organization has captured the signal the next step is to define whether it is important enough for passing it further into a sensemaking process.

2.3.2. How should we process information to find out what is important for our organization?

The impact of the collected information is defined in the process where the organization makes sense of the signals collected (Aguilar 1967, Weick 2001, Woodside 2001). The final choice for the information used in the decision-making is made in the sensemaking process (Rosa 2001). Please find more about decision making in the paper presenting the theoretical background of Case ITC (appendix 3, pages 5-7).

The structure of the sensemaking process has a major impact on information filtering strength. In order to elaborate the structural impact, I will return once again to Ansoff's filter framework. According to Ansoff (1979, 1990) power systems shape the sensemaking process. The power structure defines where the final decisions are made and when the organization chooses the way it will react to a detected clue that is found meaningful. The biasing impact of the power filter is strong (Luhmann 1995, Stacey 2001). Managers whose importance would be reduced by a new piece of information try to neglect and delay the processing of the information (Aguilar 1967). In

knowledge based organizations where expert power is essential (Hatch 1997), the structure of decision making is more complex. Experts have a role in every phase of the sensemaking process; thus the timing of the decisions in the process plays a role in filtering. If decisions about meaning of the early signs of change or selection of important signals (appreciation as Checkland (1994) and Vickeers (1965) call the phase) are made at the very early phase of the process, sensemaking dialogue is weak, or it has to be based on existing perceptions and the shared rules (Holland 1995 and 1998, Levitt & March 1988, Laztlo et al. 1993). Timing of the use of selection power is an essential element of the scanning method (Aguilar 1967).

- *Theory based insight E: The timing of the decision making has an impact on the information filters of the meaning creation process.*

The sensemaking process reduces the amount of information for another purpose, as well. As we know, one of the goals of the social system's sensemaking is to stabilize the environment and to make it more predictable (Berger and Luckmann 1966, Chia 1994, Fuller and Loogma 2008, Luhmann 1995, Weick 1995). The predictability requirement increases organizations' efficiency but leads to a reduction of information in each of the sensemaking phases. Reduction has a strong impact on the diversity of the signals, especially those that deviate from the existing mental model (Osborne et all. 2001, Schöll and Binder 2010). Multiphase processes may also have a self-corrective nature (as Augilar proposes 1967, please read elaboration about role of action in sensemaking; appendix 3 page 2) and that will increase the potential of biases (Augilar 1967 pp.10-16 Könnölä et al. 2011, Walsh 1995).

- *Theory based insight F: The number of phases in the sensemaking process will have an impact on the diversity of the scan.*

The first corporate scanning systems (Aguilar 1967, please see picture p.78, Auster and Choo 1993, Huff and Huff 2000) were management centric and hierarchical. Even if these processes were participatory that does not decrease the impact of the meaning creation methods used.

The argumentation process is a process of socialization (Nonaka, 1995, Weick 1995). This process is a prerequisite for organizations' existence (Berger Luckmann 1966, Luhman1995). In order to exist, the organization has to have a sensemaking process that leads to shared understanding. Strong sensemaking processes are inter-subjective (Luhmann 1995, Weick 2001) and consensus driven. From a scanning perspective, the request for social cohesion leads to a face-to-face sensemaking process where the common, previously held perceptions of the environment will dominate while the minority voices fade away (Klinger 1995, Hendry 2000, Hodgknison 1997and 2003, Kuusi 2000, Senge 1990). There are some special methods such as the "Devil's Advocate" or "Policy Delphi" that lead to more open results.

- *Theory based insight G: The choice of processing methods used has an impact on the information filters.*

2.3.3. What are the requirements of a complex environment?

The Ansoffian approach is linear; external information is first *collected* and then *processed.* From a systems perspective, this approach fails to take the systems nature of the global operating environment into consideration. In order to operationalize the requirements of complexity (studied in the empiric context, in the Case GCC) I will elaborate Complex Adaptive Systems theory in the next three paragraphs.

The core feature of a complex system is an *interaction* between its elements. Complexity is an outcome of emergent interactions of members of the system. It produces new types of behavior previously unseen and unforeseeable according to the current rules of behavior (Beer 1985, Casti 1995 and 2010, Checkland 1994, Johnson 2008, Stacey 2001). In systems terms, each of the subsystems (or agents) tries to optimize its fit with the environment. This requires constant interaction with the environment (Anderson 1999, Beer 1985, McKelvey 1999). Information exchange is an essential characteristic of a social system. An organization has to constantly interact in order to reaffirm its constructed identity; this is needed both for internal coherence and to differentiate the organization from its environment (Luhmann 1995, Morel & Ramanujam 1999, Stacey 2001).

Complex systems are non-linear. Small stimuli can have a large effect, and even one "weak" sign of change can be a trigger for a big change. Such change is mediated by internal and external feedback loops that can have either a positive or negative influence on the dominant perception (called schemata in Complex Adaptive Systems literature) of an organization. In order to be efficient, feedback loops have to be intensive: they have to be frequent and have the ability to carry information that is capable of shifting the schemata out of equilibrium (Anderson and McDaniel 1999, Cilliers 2000, Nicolis and Prigogine 1989).

The change in the dominating mental model of an organization emerges from tension (Berger & Luckmann 1966, Luhmann 1994, Stacey 1995). The trigger for interaction is emerging from a mismatch. When the system sees that there is a discrepancy between its intentions and reality, this initiates intensive internal and external interactions (Checkland 1994, Loveridge and CStreet 2005, Lundberg 2000, Weick 1995). If there is a gap between the system's perceived identity and the received external information, it generates tension. The higher the tension, the more motivated the

organization will be for data collection and sensemaking in internal and external interaction. Intensity can thus be seen as a combination of three features; the frequency of the feedback loops, their effectiveness, and the motivation for the interactions.

- *Theory based insight H: The intensity of interaction seems to play a role in the organization's capability to collect weak signs of change.*

Intensity is an essential feature of interaction, yet it does not cover all the features of interaction. In a complex system, all parts of the system have a rich interaction (Anderson 1999, Stacey 2001, Ulanowicz 2000), i.e. any part in the system can influence, and be influenced by, other parts of the system. In order to maximize the information flow to the organization, the interaction should cover as many external agents as possible (Dennis et al.2011, Heydai and Dalili 2013, Kauffman 1998, Lissack 1999, Proulx et al2005 Ulanowicz 2009). Connectivity has been used in mathematics and network theory to describe the number of ways in which points are connected to each other (Casti 1995). The richness of interaction can be described as 'connectivity'. In this study connectivity consists of the number of connections to the external stakeholders.

- *Theory based insight I: Connectivity of those that participate in the scanning process has an impact on collected signs of change.*

2.4. The tentative, theory based filter concept

The prerequisite for right adaptive actions in a fast-changing environment is a well-functioning environment scanning process. This requirement can be reached, on the one hand, by monitoring

diverse information, and on the other by improving the sensemaking of the information received. I try to capture these two controversial objectives in two dimensions; the width and depth of the filtering. The width represents the cognitive diversity of the data monitored. The depth represents the deepening of the sensemaking process, when the organization is integrating the selected information or any single signal of change into its meaning system. The theoretical framework reviewed in the previous chapter revealed some central insights (theory based insights A…I) that tentatively have an impact on the attributes to the information filter. These insights have been used as a foundation for the attributes, or features, of the tentative structure of information filters. (Please find more elaboration on features of information filters in one of the published papers, appendix 6, pp. 2-3)

Definitions:

> *Width* describes the diversity of the data from the data channels used and the cognitive variety of information after the filtering processes have taken place in the organization (e.g., how various potential signs of change are noticed in the processing of information).
>
> *Depth* describes the filter's capability in terms of producing plausible sensemaking information (e.g., how well the signs of change that are included in the outcome of the sensemaking process are integrated to the dominating mental model).

In practical terms: width describes the scope of information collected and it can be measured by a number of different themes presented in the scanning material. For example, a focused scan covers only the core of the existing market; a wider scan may look for changes in the fields of relevant technologies, complementary or substitute markets or even the potential development of climate change and its impacts. Depth describes how strong the social sensemaking process is in the

selection of meaningful information. Meaningfulness is measured as the overlap of the outcome of the sensemaking process with the dominating perception of the environment. Both concepts are described in details in appendix 6, pp 5-6.

I assume that the organization considers information relevant for its strategy if the information has a partial fit with existing perception, but simultaneously it is bringing something new to the existing mental model. The existing mental model of an organization is the combination of mental models of the stakeholders of the organization, and it explains the managerial decisions made in the organization (Rouleau and Balogun 2011).

The information filters of the scanning process should be flexible so that they can be modified according to the needs of the strategy process and the organizations' situation. Thus, the filter construct should consist of elements that are easy to modify.

When I cluster the theory based insights presented above, the structure of the information filters is discovered. With the term "structure," I mean a two level structure, wherein the width and depth are the first level characteristics and the features of width and depth are the second level characteristics.

By integrating theory based insights A…I to the first level characteristics, two dimensions of the filter construct, the Width and the Depth, are defined. In order to reveal the second level characteristics, I conceptualize each insight further as filter features. This requires merging of some elementary level characteristics to aggregates. After this process, the Width consists of three theory insight driven features, and the Depth is described by using four features.

The summary of the insights, literature they are based on and the filter features are presented in table 2.

Dimension	Theory based insight	Literature	Feature fo the filter construct
WIDTH	*D. Methods anonymity has an impact on social filters used in scanning process.*	Berger and Luckmann, Luhmann, Turoff,	W1: Observation methods - scanning methods used
	A. Task description of the horizon scanning process will have an impact on the cognitive filters used in the process in question.	Ansoff, Baumeister, Godet, Phelps, Weick	W2: Observation scope brief, intent
	B. Participants' cognitive structures play a key role in selection of early signs of change	Abelson, Bogrnar and Barr, Ericsson, Gioia, Luhman	W3: Quality of participants diversity of recruited mental models experience, education, identity, role, connectivity
	C. Participant's role and individual and organizational identity has an impact on signals selection.	Bar and Bar, Berger and Luckman, Luhmann	
	H. Connectivity of those that participate to the scanning process has an impact on collected signs of change.	Luhmann, Morel Ramanujam, Stacey, Cilliers	
DEPTH	*E. The timing of the decision making has impact on information filters of the meaning creation process.*	Ansoff, Luhman, Stacey, Holland, March	D1: Timing of decision making
	F. The number of phases in the sensemaking process will have a strong impact on diversity of the scan.	Berger Luckmann, Fuller, Weick	D2: Number of phases of the sensemaking process
	G. The choice of processing methods used have impact on the information filters.	Weick, Klinger, Hendry, Hodgkinson, Senge,	D3: Nature of evaluation method(s) used
	I. The intensity of interaction seems to play a role in organization's capability of collecting weak signs of change.	Casti, Cilliers,Luhmann, Lundberg, Kaufman, Lissack, , Stacey, Ulanowicz	D4: Intensity of interaction, frequency of interaction, motivation to the interaction

Table 2: The structure of the information filter construct and the literature behind each of the features of the construct.

III Research design for the testing of the proposed filter theory

The filter theory presented in the previous chapter has its roots in decision making, strategic planning and systems theories. The aim of the empirical study is to test the filter theory's validity. This was achieved by conducting four comparative case studies that are reported either in peer-reviewed conference or journal papers. In each of the four cases, we used different filter settings and sensemaking processes. The web-based tool used for data collection in horizon scanning processes was modified so that it met the requirements of the hypotheses testing of different filter construct features. This setting also served as a test for the feasibility, controllability and explanatory power of our filter construct.

Three globally operating companies and one international research center were chosen for the case studies. The common denominator for the cases was that the environment scanning took place at an early phase of the planning process. Three out of four scanning processes studied were part of corporate strategy building. The forth of the processes analyzed, the Case IRO, was a strategic risk scan. The main objective in all of the organizations studied in cases was to identify early signs of previously unseen change.

3.1. Methodology

As my main interest is in the model building, the case method was the chosen strategy. As the research papers (appendices 2-6) indicate; the theory building process involved interaction between the theoretical frameworks and empirical data collected in the case studies.

The process was iterative (Miles & Huberman 1984, Eisenhardt 1989, Forssén 2002). The applied theoretical frameworks defined the research design of the first two cases Case ICT and Case IRO, the outcomes of these cases in turn defined the focus of the third case studied, Case GEC. An analysis of the outcomes of these three cases necessitated a closer look at the Complex Adaptive Systems theory (CAS) framework and generated a need for an additional feature in our filter construct. The fourth case study, Case GCC, was required for testing this new feature.

The research design is comparative (Yin 1984). I tested the potential impacts of the different features of the filter construct by comparing the outcomes of the different types of scanning processes.

In two of the cases, Case ICT and Case IRO (please look at the cases in the Appendices 3 and 5) I compared a traditional, social interaction based scanning process with the web-process featuring a wide-filter construct. The third case, GEC (appendix 6) was dedicated to comparing different sensemaking methods, which were used simultaneously by four similar groups within the same organization (appendix 6, page 9). The fourth case, Case GCC examined the impact of different kinds of participant groups on the outcome of the scanning process.

CASE	FOCUS	PUBLISHED IN	STRUCTURE OF FILTER	IMPACT OF FILTER STRUCTURE
	Literature review	iKnow	What are the obstacles of processing of new information in the strategy process?	
CASE ICT	Two different visioning processes; traditional multi-phase meeting process and web-based flat collection and analysis process.	sms2002	What is the structure of the information filters that filter weak signals during corporate vision building processes?	What are typical features of the identified filtering mechanisms during real-life operation?
CASE IRO	Comparison of a standard quantitative risk assessment procedure (FMEA) and web-based qualitative risk scanning process.	Sms2005	What is the schema(ta) and the sense making process in particular when the risk stimulus is weak or tacit by its nature?	
CASE GEC	Comparison of different means of collecting and analysing weak signals. The construct is tested with 4 different group processes and filtering dynamics in each of the groups described.	Futures	What are the features of weak signal filters?	What are the impacts of the filters on decision making?
CASE GCC	Collection of signs of change in the operating environment. Comparison of the outcomes of groups with different kinds of interaction background.	Foresight	In the early phase of the strategy process, what structural features are relevant for the information filters?	What are the impacts of filters with different widths and depths on the practical outcomes of the environment scanning process?
Summary		Dissertation	What is the structure of the information filter used in the environment scanning process?	What is the impact of filters of different width and depth on the outcome of the environment scanning process?

Table 3. The case specific research design, publication (please. look at appendices 3, 5-7) and research questions.

3.2. Hypotheses

Each of the case studies reported in published papers consists of two elements, literature review and hypotheses testing. The key findings of the literature reviews have been summarized as theory driven "insights". These insights are essential for the formation of features of the filter construct. Insights lead to the hypotheses about the impact of the filter features on the horizon scanning process outcomes. The empirical case studies are designed for hypotheses – and thus filter construct testing.

The hypotheses can be summarized final conclusions as six theory driven hypotheses H1-H6.

Hypothesis 1: A scanning process relying on social interaction implies less width than a web-based anonymous process.

Hypothesis 2: Open task description produces width as a heterogeneous output.

Hypothesis 3: Diversity of participants increases width as cognitive diversity of the scanning process outcome.

Hypothesis 4: The depth of the sensemaking process measured with the number of successive sensemaking stages increases shared understanding as shared schemata.

Hypothesis 5: Depth of the filter reduces controversial information.

Hypothesis 6: High connectivity, low intensity participants will produce the width as a wider diversity of the scanning outcome than low connectivity, high interaction participants.

Theory based insights that led to the hypotheses presented above are summarized in the in the table 4.

HYPOTHESES	FEATURE OF FILTER CONSTRUCT	THEORY BASED INSIGHT
Hypothesis 1: Scanning process relying on social interaction implies less width than web-based anonymous process.	W1: Observation methods - scanning methods used	*D. Methods anonymity has an impact on social filters used in scanning process.*
Hypothesis 2: Open task description produces width as heterogeneous output.	W2: Observation scope brief, intent	*A. Task description of the horizon scanning process will have an impact on the cognitive filters used in the process in question.*
Hypothesis 3: Diversity of participants increases width as cognitive diversity of the scanning process outcome.	W3: Quality of participants, diversity of recruited mental models, experience, education, identity, role, connectivity	*B. Participants' cognitive structures play a key role in selection of early signs of change*
		C. Participant's role and individual and organizational identity has an impact on signals selection.
		H. Connectivity of those that participate to the scanning process has an impact on collected signs of change.
Hypothesis 4: The depth of the sensemaking process measured with the number of successive sensemaking stages increases shared understanding as shared schemata.	D2: Number of phases of the sensemaking process	*F. The number of phases in the sensemaking process will have a strong impact on diversity of the scan.*
	D3: Nature of evaluation method(s) used	*G. The choice of processing methods used have impact on the information filters.*
Hypothesis 5: Depth of the filter reduces controversial information.	D1: Timing of decision making	*E. The timing of the decision making has impact on information filters of the meaning creation process.*
Hypothesis 6: High connectivity, low intensity participants will produce width as a wider diversity of the scanning outcome.	W3: Quality of participants' connectivity	*H. Connectivity of those that participate to the scanning process has an impact on collected signs of change.*
	D4: Intensity of interaction, frequency of interaction, motivation to the interaction	*I. The intensity of interaction seems to play a role in organization's capability of collecting weak signs of change.*

Table 4. All of the hypotheses were testing one or two features of the filter structure. Table connects hypotheses to the theory based insights, which build up the foundation for the filter construct.

Each of the case studies was independent. The hypotheses tested were case specific, and the construct tested was slightly different as described in the table 5.

		Case ITC	Case IRO	Case GEC	Case GCC
	Paper published	SMS 2002	SMS 2005	Futures Journal	Foresight
Target of the filtering process	Feature related hypotheses	Hypotheses	Hypotheses	Hypotheses	Hypotheses
Width	Hypothesis 1: Scanning process relying on social interaction implies less width than web-based anonymous process.	ITCH1: Scanning process relying on social interaction is producing narrower information filters than anonymous process and thus is producing less diverse scanning outcome.		GECH1: Social interaction as a processing method will reduce the width of the filter.	
	Hypothesis 2: Open task description produces width as heterogeneous output.	ITCH2: The variety of selection criteria increase the width of information filters and result in a large variety of weak signals as output.	IROH1: Well-defined briefings and argumentation requirements with exact evaluation criteria produce a narrower filter.	GCEH2: The open scope of the briefing increases the width of the filter.	
	Hypothesis 3: Diversity of participants increases width as cognitive diversity of the scanning process outcome.	Hypothesis 3: The diversity of participants and the variety of selection criteria increase the width of information filters and result in a large variety of weak signals as output.	IROH2: Diversity of participants produces a wider filter and thus increases diversity in the mental model.		GCCH1: High connectivity produces a wider filter and a greater variety of outcome.
Depth	Hypothesis 4: The depth of the sensemaking process measured with the number of successive sensemaking stages increases shared understanding as shared schemata.	ITCH4: Specialized expertise and a multi-step argumentation process increase the depth of the information filter and promote deeper insight into new features of the operating environment as output.	IROH3: A multiphase process produce a deeper filter, that which produces a focused mental model.	GECH3a: A multi-step process increases the depth of the filter promoting strong argumentation.	
	Hypothesis 5: Depth of the filter reduces controversial information.	ITCH5: Late decision making increases filter width and helps to elicit a large diversity of input into the vision process.		GECH3b: 3 supposed that the social interaction as a processing method will increase the depth of the filter but will reduce the width of the filter.	
	Hypothesis 6: High connectivity, low intensity participants will produce width as a wider diversity of the scanning outcome than low connectivity, high interaction participants.				GCCH2: High internal intensity produces a stronger dominating model.
					GCCH3: High external connectivity and low internal intensity produce more variety in outcome than do low external connectivity and high internal intensity.

Table 5. Hypotheses tested in each of the cases. Please note that the formulation of hypotheses of the case studies was case specific and thus does not directly follow the classification of the summary. A detailed summary of the case specific results is in appendix 1.

3.3. Data collection

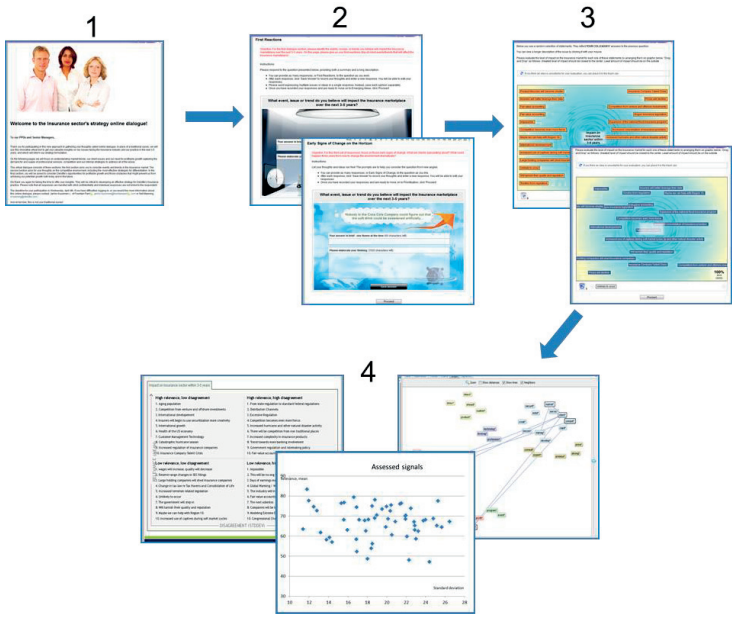
In three of the cases, I studied the first phase of the strategic planning, environment scanning process that produces the input to the strategy process. The first case organization was an international communications technology company (Case ICT), and the processes studied were the visioning process of its research organization (described in details in appendix 3, pages 9-11). The processes investigated were similar in the globally operating energy company (Case GEC, published a paper in appendix 6) and in the global management consulting company (Case GCC, published the paper in appendix 7). All three of these organizations were commercial corporations. The fourth of the cases was a bit different; the case organization was an international research organization (Case IRO, published a paper in appendix 5). I studied the strategic risk scan of one of their state-of-the-art measurement projects. The motivation for the choice of the risk scan as a case was to look at the information filters in a very specific cognitive framework (Baumeister 1996, Tenbrunsel et al. 1996, Weick 2001).

The data collection setting was driven by the requirement of comparative setting, where outcomes of different scanning processes were compared with each other. Testing of the extended filter theory required a special data collection and analysis method. The method allowed me to customize the information filter structure according to needs of the hypothesis's testing. The web-tool was named the Signals Toolset, and it was used in all of the case studies reported in this dissertation.

In two cases, I compared participatory web-based method with the previous year's method used traditionally by the case company. In the Case ICT, the traditional method was a bottom-up meeting based process. In this hierarchical funneling process, the team meetings produced a list of early

signs of change to the department level, and the department level selected a set of signs of change to the unit level. In the Case IRO, the traditional method was the Failure Mode Analysis. The FMA in question was an excel-based assessment of each line of the project actions list. In the Case GEC, the comparison was conducted between four groups that simultaneously run a horizon scanning process with different methods (different filter construct settings). In the Case GCC, we compared web-collected data by the nature of different respondent groups. (Detailed descriptions of the data collection methods are in appendices 3-6.)

The data collection was conducted using a web-based toolset (picture 3) that is designed so that different filter elements are easy to adjust according to the needs of the case and hypothesis testing requirements. Filter construct can be adjusted by managing the diversity of participants (W3 and D3), by formulation of the background description of the framing of the questions (W2), filtering some part of the collected data to the assessment phase (D1) and by managing sequences of web-phases and social interaction (W1 and D2). The toolset is described in detail in appendix 2.



Picture 3. Web-based scanning process provided us with an opportunity to invite (1) a large variety of participants. Questions (2) are presented, and the collected ideas are assessed (3) in a way that opens cognitive filters (de Bono 1973). The analysis is mainly automatic, and the preliminary reporting (4) does not contain any interpretation of the facilitator/researcher. Please find more detailed description in appendix 2.

3.4. Analysis methods

For the hypothesis testing purpose, it was essential to be able to measure cognitive diversity of the material in different phases of the scanning and sensemaking process. The method used reported both the cognitive diversity (width) and the plausibility (depth) of the outcome of the scanning process. In order to assess the reliability of the method used for and validity of its results (Eisehardt 1989), I describe the analysis method briefly (please find a detailed description in appendix 2).

The software tool produced an automatic text mining report, showing the data clustered according to the most frequently used concepts in the material. The clustering is used as a basis for classification and detailed analysis of the material produced by the respondent groups.

The diversity of the themes in the data is used as a measure of the cognitive width of the filter construct that is applied in the scanning process under investigation. Diversity of themes was measured by the number of exclusive clusters of issues, and the number of comments per cluster was calculated for drawing a case specific profile.

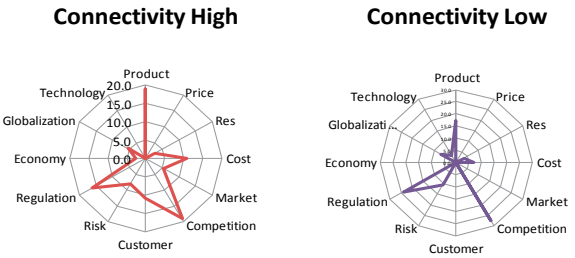
The filtering impact of the sensemaking process was calculated by comparing the themes of all the produced signals to the themes of the process outcome report.

Moreover, the computed report produces a basis for measuring plausibility of the sensemaking process outcome. Plausibility is assessed by comparing the match of the clusters represented in the final report to the themes of the dominant mental model. The dominant mental model is presented in a report that lists those signals that all the respondents see important (average importance is high and standard deviation is low). (Please find more detailed description of the report in appendix 2.)

Width: An example of the analysis.

As an example, I present an analysis of Case GCC data. In this example, the width of the information filter has been studied by focusing the attention on one of its features: interaction connectivity (feature W3, please see more on page 26) of the participants. As stated earlier, connectivity is measured by the amount and variety of connections.

The example studies the hypothesis 2; *High connectivity produces more variety in outcome.* Below are two respondent groups, one with high connectivity to the environment and the other with low connectivity.



Picture 4: The same clustering criteria have been applied to the responses of these two different respondent groups. "Connectivity high group" consists of senior consultants operating across different industries, with plenty of client connections. Specialized junior consultants with plenty of back office responsibilities are grouped in the connectivity low group.

When I compared the profiles, I found that, in the material produced by the high connectivity group, there is a higher number of addressed themes and more diverse range of comments (the cognitive variety is higher). My conclusion is that the hypothesis presented in the case study (see appendix 1) is supported. In the horizon scan where participants have numerous connections outside of the organization, the filter is wider and produces greater cognitive variety.

Principles

Even though the research questions were case specific, all the questions aimed at describing and analyzing some feature(s) of my extended filter theory. Testing was conducted in three phases, and it was based on the theory-based hypotheses on the impact of different filter structures to the outcome of the scan.

1. The scanning process was customized so that the filter construct under investigation was the distinctive feature of the process.
2. Data was collected both with the traditional, social interaction based method (4-60 participants) and the web-based method (20-3000 participants).

3. The impact of the filter feature tested (such as the impact of the open brief W2) was studied by comparing the results of the horizon scanning process (structure of the mental model) with the relevant reference outcome (to the outcome of the hierarchical process and/or the outcome of the other groups).

IV Review of findings

In this chapter, I describe the findings of the four case studies presented in the four published papers from three perspectives. The findings of the extended information filter theory are summarized first. The implications on the management challenges will be described in chapter 4.2.

4.1. Extended information filter theory

The basic assumption behind the study is that the information scanning and sensemaking process has a filter or multiple filters. Theoretical background studied; theories of Ansoff, Weick, Beger and Luckmann and Luhmann (Ansoff 1990, Weick 2001, Beger and Luckmann 1966 and Luhmann 1995) imply that the information processes have filtering mechanisms. I have clustered the theoretical frameworks into one concept that defines two key dimensions; width and depth of information filter. The empirical material has been tested (by presenting a set of hypotheses on filter features) with different kinds of filter features. Results show that different kinds of filters have a different impact on the outcome. The hypotheses tested are in details presented in the papers attached (appendices 3, 5-7). I have summarized the findings of the hypotheses testing in the table of the appendix 1.

4.1.1. Tested hypotheses on the width

W1, Observation collecting methods, used: This feature was studied in Cases ITC, IRO and GEC. The results reveal that the method has an impact on results of the information scan and the sensemaking process. The Case ITC (appendix 3, page 12) produced more variety in the outcome, and the Case GEC web-based methods produced more various materials than social interaction (appendix 6, page 10); thus the results indicate that a web-based, anonymous scan produces more variety in the outcome. The respective outcomes were measured by cognitive variety.

Feature W2, Observation scope, used: The comparison of the outcomes of the three studies (especially the comparison of outcomes of a well-defined, detailed brief and open scope brief in the Case GEC, appendix 6, proposition 1, p. 10) tell us that feature W2, the observation scope, has a clear impact on the outcome of the information scan: a wide filter enhances the diversity of information detected.

Hypothesis 1: Scanning process relying on social interaction implies less width than web-based anonymous process. (W1, D1)

Hypothesis 2: Open task description produces width as heterogeneous output. (W2)

Hypothesis 3: The diversity of participants increases width as cognitive diversity of the scanning process outcome. (W3)

Hypothesis 4: The depth of the sensemaking process measured with the number of successive sensemaking stages increases shared understanding as shared schemata. (D2, D3)

Hypothesis 5: The depth of the filter reduces controversial information. (D3, D4)

Hypothesis 6: The high connectivity, low intensity participants, will produce the width as a wider diversity of the scanning outcome than low connectivity, high interaction participants. (W3, D4)

Feature W3, The nature of the participants: The different processes studied in Case ITC and Case GEC were too similar in their participant structure. Therefore, the impact of feature W3 could not be tested properly (appendix 6 p.23). In Case IRO, I had a more favorable research design, and the results strongly supported (the diversity of the outcome was more than double of the traditional Failure Mode Analysis, please look at appendix 5 p.5) our hypothesis that the composition of the participant group has an impact on the variety of data collected. Case GCC indicates that connectivity also has an impact on the filter shape. Respondents with many external contacts had a more diverse observation profile compared to those respondents with lower connectivity.

4.1.2. Tested hypotheses on the depth

The depth refers to the structure of the sensemaking process. In our construct, I divided depth into three features.

Feature D1, Timing of the decision making: Case ITC (appendix 3, page 12) provided us with support for the impact of timing in decision making. It seems that the late decision making will enhance the diversity of the outcome of the sensemaking process. The hypothesis as such was not tested in other cases, but the results of Case IRO, (pages 5-6) support this conclusion. When the interpretation/assessment of potential implications is postponed, a greater number of classes of potential risks are identified.

Feature D2, The number of phases in the sensemaking process: Cases ITC and GEC supported the construct. In case GEC, the multi-stage workshop reduced the material into a couple of issues that reflected the mental model of the company. Thus, I claim that the number of sensemaking process

phases has an impact on the outcome. The more phases the process includes, the less diversity (i.e., the stronger the shared mental model) there is in the outcome.

Feature D3, The nature of the evaluation method: Case IRO and GEC support the importance of this feature in our construct. If the evaluation method is highly detailed or the analysis is based on social interaction (Case GEC in appendix 6, p. 10, proposition 3), the outcome has less diversity than in a case where evaluation takes place virtually and/or qualitatively without detailed argumentation requirements. In Case ITC, I did not test this hypothesis, but the outcomes of the two visioning processes support this conclusion (please see appendix 3 p 11).

Feature D 4, Intensity of interaction: This interaction feature was tested only in the fourth case. Case GCC results indicate that an internal interaction influences the sensemaking as I anticipated: in the cases where participants have more internal interaction; their shared perception was stronger than those without internal interaction.

Paper published	SMS 2002	SMS 2005	Futures Journal	Foresight
HYPOTHESES	**CASE ITC**	**CASE IRO**	**CASE GEC**	**CASE GCC**
Hypotheses 1: Scanning process relying on social interaction implies less width than web-based anonymous process.	Support		Support	
Hypotheses 2: Open task description produces width as heterogeneous output.	Support	Support	Weak support	
Hypotheses 3: Diversity of participants increases width as cognitive diversity of the scanning process outcome.	Not analyzable	Support		Weak support
Hypotheses 4: The depth of the sensemaking process measured with the number of successive sensemaking stages increases shared understanding as shared schemata.	Weak support	Remains open	Weak support	
Hypotheses 5: Depth of the filter reduces controversial information.			Support	Support
Hypotheses 6: High connectivity, low intensity participants will produce width as a wider diversity of the scanning outcome than low connectivity, high interaction participants.				Support

Table 6. A summary of the hypothesis's testing. Support implies that the empirical material supported the hypotheses without any doubt, when weak support indicates that empirics was aligned with the hypotheses, and open indicates that data did not prove the hypotheses right or wrong.

It is obvious that the method where there are many, diverse, anonymous respondents that are producing material to the open scanning challenge produces more cognitive variety than the traditional analytical face-to-face based horizon scanning.

In summary of the results of the comparative analysis of the cases and their different outcomes with different filter construct designs, I can conclude that the seven filter features described have an impact on the outcome of the scanning process.

V Conclusions and Discussion

5.1. Research questions and central findings

The research questions of this study were: What is the structure of the information filter of the environment scanning process? What is the impact of filters of different width and depth on the outcome of the environment scanning process? For this purpose, I developed a theory-based structure of information filters.

In order to validate the filter structure developed, I studied the impact of the different features of the information filters used in the four organizations.

The central features of the theory based filter construct were operationalized as a set of hypotheses. Hypotheses testing required a scanning method that was easy to be modified according to the requirements of hypothesis's testing. The comparative hypotheses testing required interpretation-free reports, as well. For this purpose, we developed a software toolset.

To gain an understanding of generic features of the filter construct, I had to run extensive testing; I studied 10 different scanning processes. All of these processes had the same function: all were used to produce input about the change of the environment for the strategy planning processes.

Comparability of this study is thus based on three aspects. First, the horizon scanning processes served similar purposes. Second, the modification of filters used in the studies was operationalized with the same data collection method. Third, the aspect facilitating comparison between cases was the automatic analysis method used for qualitative data collected.

Central finding

The results of the case studies presented indicate that a deep, narrow filter produces a well-focused, very plausible, homogenous output in a horizon scanning process. A flat and wide filter produces a diverse set of issues. Diverse signs of change may challenge existing mental models and thus bring new elements to the strategy process.

5.2. Validity, reliability and limitations

The study reported in this dissertation is qualitative. As stated in the research questions, the goal of this research project has been to understand the structure and the role of information filters in the horizon scanning process. Data collected was qualitative by its nature, so it is natural to apply the validity and reliability rules of qualitative research (Strauss and Corbin 1990). Because the method developed for data collection was in principle a survey, I am able to apply some of the validity and reliability criteria of quantitative studies, as well. I will start the research quality elaboration with validity assessment of data collection and then look closely at the potential biases of the conclusions of the qualitative study.

Reliability and validity of data collection process

Reliability is considered to be high when the repeatability of the study is possible – or even easy (Suppe 1977, Golafshani 2003). The research method developed is easy to apply to any organization with exactly the same settings as used in my case studies. If the aim is to repeat the measurements within the same organization, there are some limitations. In the case where the results of the previous measurement have been communicated to the organization, the organization

has discovered their cognitive biases (according the unpublished studies conducted after these case studies) and thus the organization's cognitive structure has changed.

The toolset developed supports the validity of the study, as well. The tool can measure and report the cognitive variety of the output for the scanning process. For the assessment of width, the tool is very strong. The depth of the information filters (measured by the overlap of the dominating mental model and the outcome of the process) is strong as well, but this feature could have been exploited even further in the analysis phase. The qualitative nature of the data still presents a potential bias here. Accuracy of measurement is highly dependent on the classification criteria that are the basis of the automatic analysis.

Trustworthiness of results

Qualitative study can be assessed by using three perspectives (Davies and Dodd 2002, Golafshani 2003): rigor or consistency of data and analysis, trustworthiness or defensibility of findings and lack of bias by applying triangulation (Patton 2002). The data was collected by using only one method; thus I did not use triangulation in data collection. The only way to triangulate was built-in reporting. I reported conclusions of every case study to every organization, and they were validated by organization's own experts. As explained in the previous paragraphs, due the nature of the data collection method, the consistency of data and thus rigor of the study is easy to explicate. The third criteria, "trustworthiness" is a more complex issue. According to Stenbacka (2001) trustworthiness can be assessed by the generalizability of the results. In this study, I was able to show that the information filter construct developed behaved in an expected way in four

organizations and 10 processes. The final generalization power will be proven in the future research.

Limitations

The four cases mainly supported the hypotheses developed. But even if the overall structure of our model for information filters of the scanning process has been supported, some discrepancies remain.

The literature used as a theoretical background of this study focuses on the early phase of the strategy process, the information collection and processing procedures. It is essential to note that other factors also have an impact on the results of the scanning results. The efficiency of the horizon scanning process is also dependent on such factors as size of investment in environment scanning methods, amount of resources dedicated for environment scanning and the strength of participants' motivation (scanning as one of the rewarding criteria, scan only as a semi-voluntary activity).

As stated in the description of the methodology, the research was based on a constant dialogue between the theoretical framework, my construct and the data of the case studies. The analysis of the first three cases showed that I have to include complex systems theory features that will explain the filter structure in a complex framework to my construct. For the fourth case study, I created a research design with one additional feature for each *width* and *depth*. This allowed us to describe the filter depth better. This late finding was tested in only in one case (Case GCC) only, which severely limits the reliability of our testing.

A possibly more serious oversight is that the research scope of this study covered only the early part of the strategy process, and it did not study the impact of detected signs of change on the strategy process or decision making. I had no opportunity to follow up one specific sign of change and its impact in the organization's strategy process.

5.3. Scientific contribution

In chapter 2.2, I described the research gap that this study aimed to fill. Igor Ansoff (1970, 1984) perceived the environment scanning process as a managerial process where the environment was relatively stable, and the manager's responsibility was to collect information, consider its value and implement the required changes. The process was linear, and information filtering was mainly related to the management's personal characters and mental models (Ansoff 1984). In order to cover the missing features of Ansoff's filter theory I have studied social constructionism (Berger and Luckmann), sensemaking (Weick) process, social systems theory (Luhmann) and Complex Adaptive Systems theory (Andersson, Holland). The results of the literature analysis (described in chapter 3) are summarized into nine theory driven insights. The collected insights have been used to develop Ansoff's filter concepts into an extended filter theory that will apply better into current horizon scanning challenges.

I perceive that the contribution of this study to the filter theory is related to the complexity. In order to meet the requirements of the complex, turbulent environment I have replaced the managerial centrality with an organization wide approach, where the information filters are not related anymore only to the manager's capabilities, but to the whole scanning process and its participants. The linear setting of three filters; surveillance, mentality and power filters (Ansoff 1984) have been

replaced by introducing a new multidimensional filter construct that can explain the filtering impact of the information collection and processing methods throughout the horizon scanning process.

The second contribution emerges on operationalization. The extended filter theory was operationalized into the two-dimensional filter construct that was tested in the empirical cases. Based on the empirical testing results, I can claim that the construct defined describes the generic structure of information filters in the horizon scanning. The dimensions width and depth and their functional features describe how an information filter works in this process in a complex environment.

I have applied the Complex Adaptive Systems theory framework to existing environment scanning theories. The resulting study was able to reveal the key role of internal and external interactions within a horizon scanning process. The importance of wide participation has been addressed widely (one of the recent examples Dortland, Voordijk, Dewulf 2014), but the role of interaction in the horizon scanning process has not been addressed in the foresight literature reviewed in this study (for example the Special Issue of Futures Journal April 2012: Volume 44, Issue 3, pages 195-276). As I see this feature essential in a complex environment, I perceive this revelation to be my main contribution to the scientific body of knowledge of the field.

5.4. Managerial implications

From management's perspective, the key question is: how to design information filters in such a way that the information can be used either for increasing resilience or for stabilizing an organization that is in flux? First I focus on the situation where management wants to increase

organization's flexibility and then I will describe how to design the horizon scanning process for the purpose of stabilizing an organization by controlling information intake.

If the organization is too stable to innovate or develop, the recipe for destabilization by adjusting information acquisition is simple: A wide and flat filter imports a larger amount and more diverse signs of change (information) to the organization. The CAS framework that I have applied above claims that in order to destabilize an organization (to increase its flexibility), it is enough to inject the organization with a maximal amount of "disturbing" external information.

According to the findings from the case studies, a destabilizing filter design for this purpose would include the following features:

- A web-based, anonymous scanning method
- An open briefing, which allows or even enhances collection of information that challenges the existing mental model
- A large and diverse number of participants, including those with the best external connectivity
- Minimize the number of hierarchical phases that select the data for the next phase
- Postpone the final choice of information that is used for the decision making as late as possible
- And the last – and most important – feature: go back to the environment and frequently check on how your conclusions actually fit reality (maximize the number of feedback loops)

Even if increasing volatility requires flexibility, it is not always the main strategic challenge. For a start-up company, it is essential to build a strong sensemaking system. The same need for efficient

sensemaking is also in organizations that are struggling with a post-merger integration process. The construct I tested indicates that if stabilization is needed, managers should scan the environment with a process that has a narrow and deep information filter design. According to the findings from the case studies, a stabilizing filter designed for this purpose would include the following features:

- An organization wide process for generation of a shared mental model of the environment (deep inclusive process builds shared perceptions)
- A separate scanning processes for different groups of expertise, so the shared sensemaking within a group is stronger
- A very focused briefing
- An internal sensemaking process that consists of intensive and frequent internal face-to-face interactions
- Feed-back loop needed; communicate the results back to organization

(More elaboration of filter details in appendix 3 pages 3-4.)

5.5. Areas for the further research

There is a clear need for further research in three areas. First it is essential to study more about internal and external information exchange (interactions) and their role in the filter structure. Feedback loops are the essential part of a complex system, but horizon scanning literature does not pay attention to this feature. The second area that requires in-depth research is the dynamics of the sensemaking process. A scanning process is a learning process, and identified biases may have a radical impact on the next horizon scanning process.

Third the most important area deserving a more comprehensive study is the impact of a scanning method – and applied filter structure – to the reaction time of the organization. Mental models change slowly, and without conscious management of the process, this change requires plenty of supportive information from different sources. Uncertainty of the business environment is increasing, and reactions should be faster. The question to be studied further is: What are the distinctive qualities of the scanning function and the sensemaking process that lead to successful adaptation in the complex, fast changing environment?

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APPENDIX 1

Table summarizes the results case by case.

		Case ITC		Case IRO		Case GEC		Case GCC	
	Research lay-out	Comparative analysis of two consequent visioning processes, traditional bottom-up meeting analysis and new virtual democratic process.		Comparative analysis of two different kinds of risk assessment methods; traditional structured FMA method and open participatory process.		Comparison of different means of collecting and analysing weak signals. The construct is tested with 4 different group processes and filtering dynamics in each of the groups described.		Comparison of scanning and sensemaking results of different kinds of participant groups.	
Target of the filtering process	**Feature related hypotheses**	**Hypotheses**	**Results**	**Hypotheses**	**Results**	**Hypotheses**	**Results**	**Hypotheses**	**Results**
Width	Hypotheses 1: Scanning process relying on social interaction implies less width than web-based anonymous process.	ICTH 1: Scanning process relying on social interaction is producing narrower information filters than anonymous process and thus is producing less diverse scanning outcome..	Anonymous nature of the process. In the web-aided process, the input creators and evaluators were anonymous, and that changed the mental model of the participants.			GECH1: Social interaction as a processing method will reduce the width of the filter.	The hypothesis is supported by reference to the fact that with virtual methods the outcome had more diversity/variety of themes, more vivid descriptions, and the number of radical ideas was higher than in the social interaction process of the workshops.		
	Hypotheses 2: Open task description produces width as heterogeneous output.	ICTH2: The variety of selection criteria increase the width of information filters and result in a large variety of weak signals as output.	The wider selecting criteria mentioned really indicated the diversity of the outcome.	IROH1: Well-defined briefings and argumentation requirements with exact evaluation criteria produce a narrower filter.	The hypothesis concerning the nature of the briefing was supported. Exact, well-defined briefing produced a narrower, closer to the existing shared mental model (less deviation in evaluation) outcome.	GECH2 The open scope of the briefing increases the width of the filter.	The results of the study do not provide very strong support for the hypothesis when the diversity of the signal categories is analyzed, but the number of produced signals was larger in the case of the open question.		
	Hypotheses 3: Diversity of participants increases width as cognitive diversity of the scanning process outcome.	ICTH3: The diversity of participants and the variety of selection criteria increase the width of information filters and result in a large variety of weak signals as output.	The hypothesis of the diversity of participation did not get any support.	IROH2: Diversity of participants produces a wider filter and thus increases diversity in the mental model.	The empirical results strongly support the first part of hypothesis. Wide participation increases diversity in the sensemaking process and produces a more complex mental model as an outcome of the process.			GCCH1: High connectivity produces a wider filter and a greater variety of outcome.	The results of the study provide a strong support for the hypthesis. Respondents with a position that required plenty of external contacts for various stakeholders had a more diverse observation profile than those with lower connectivity.
Depth	Hypotheses 4: The depth of the sensemaking process measured with the number of successive sensemaking stages increases shared understanding as shared schemata.	ICTH4: Specialized expertise and a multi-step argumentation process increase the depth of the information filter and promote deeper insight into new features of the operating environment as output.	Results do not support this hypothesis at all. An internal need for credibility more or less inhibited their explication of novel, 'outside-the-box' paradigm ideas (Kuusi 2000).	IROH3: A multiphase process produce a deeper filter, that which produces a focused mental model.	The hypothesis remains open in this case: the material did not produce enough evidence about the impact of the phases on the filter and mental model. Differences of phases in the cases were not sufficient for drawing conclusions.	GECH3a: A multi-step process increases the depth of the filter promoting strong argumentation.	The one-stage processes did produce more variety in themes than the two-stage process. In the two-stage process participants reduced the complexity of the data collected. The group also reduced the complexity of the descriptions by deleting some of the issues in them. A two-stage workshop produced fewer issues per description but simultaneously longer argumentation chains in the outcome. Thus the proposition was supported.		
	Hypotheses 5: Depth of the filter reduces controversial information.	ICTH5: Late decision making increases filter width and helps to elicit a large diversity of input into the vision process.	These results provide support to proposition.			GECH3b : Social interaction as a processing method will reduce the amount of controversian material.	The hypothesis was supported. Social interaction in the workshops produced less radical ideas than a virtual process. The support for hypothesis was not very strong, because virtual process produced a relatively longer argumentation chains. So even if the overalp with the dominating mental model was clear, the argumentation in the social interaction was not deeper.	GCCH2: High internal intensity produces a stronger dominating model.	Participants with a lot of internal interaction seem to share the same mental model with less diversity.
	Hypotheses 6: High connectivity, low intensity participants will produce width as a wider diversity of the scanning outcome than low connectivity, high interaction participants.							GCCH3: High external connectivity and low internal intensity produce more variety in outcome than do low external connectivity and high internal intensity.	The combined hypothesis gains moderate support by data collected.

APPENDIX 2 The Signals Toolset

The operationalization of the theories applied – Ansoff's filter theory, Weick's sensemaking theory and the principles of Social Systems theory and Complex Adaptive Systems theory described in the summary – is embedded to the data collection developed for collection. The Web-based toolset facilitates both the hypotheses-driven empirical testing via adjustment of different filter elements but also the analysis of the outcomes. By web-based we mean a hypertext based survey tool that is distributed and responded via the Internet in the World Wide Web.

The tool promotes wide participation in "sensemaking" in an organization trying in to handle the problems related to filter dimensions W1 and D1, and to promote the positive aspects of deep filters related to filter element D4. The anonymous collection and assessment processes are aimed at increasing the width of filtering (W1). As well as members of the organization, people or experts outside the organization have in many cases participated in the filtering processes. This promotes the connectivity of the organization (W3, D4). Together with the anonymity, the participation of outsiders reduces the risk of the "group think."

The possibilities of testing a single hypotheses with the toolset are especially relevant to filter elements W2 and W3. The systematic testing of the other kinds of hypotheses than those

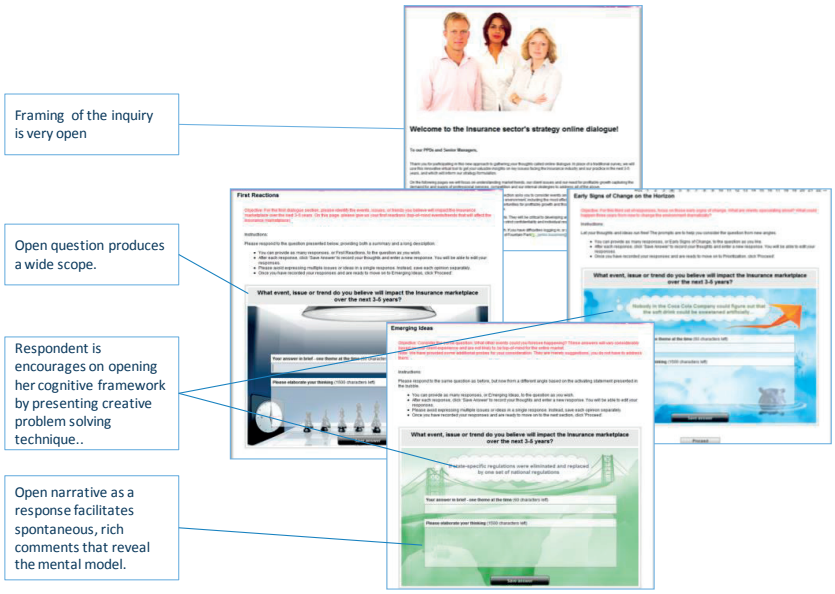
presented in the summary is also possible in principle, but requires special arrangements that are not easy to achieve.

The data collection by using the toolset can be summarized as follows:

1. Selection of the panelists and contact with them via e-mail
2. Participating panelists provide the survey with their background information
3. Panelists suggest anonymously possible signs of change in the Internet
4. Participants assess the importance of the collected signs of change. The toolset provides each participant with a random set of proposed signs of change for his/her assessment.
5. Panelists evaluate the importance of the signs of change in the way illustrated in the picture. They can also make written comments on the Web that can be seen by other evaluators
6. The averages and variances of evaluations are used in the classification of the signs of change.

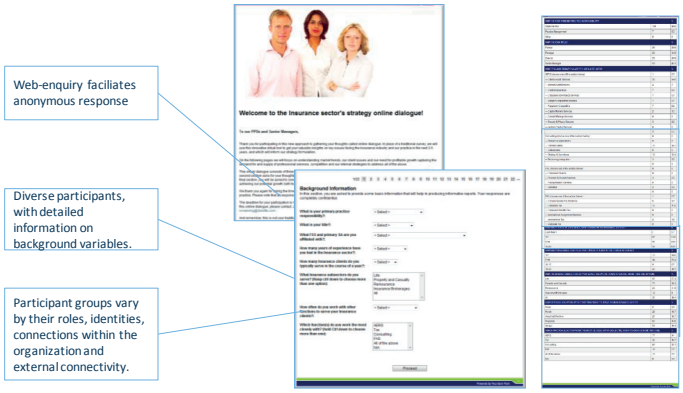
The toolset was used in all four case studies. I illustrate the through screenshots and discuss closely some aspects of the toolset.

Let us start with the description of the toolset from the information acquisition phase.



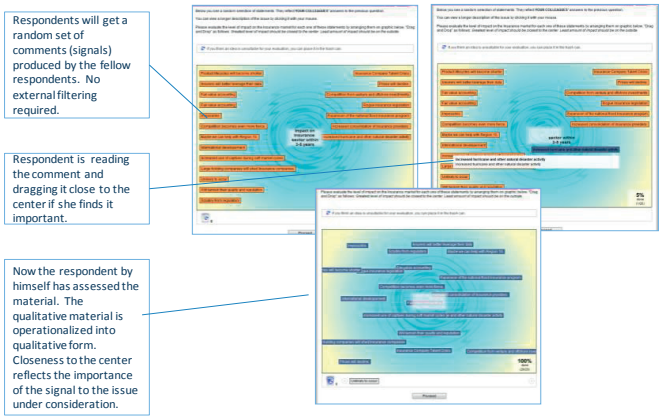
Picture 1. The brief and survey questionnaires of the Signals Toolset.

Observation method and scope: The framing of the scanning task can either be very well specified, or, if the aim is to detect early signs of disruption of an organization's schemata, as open as possible (element W2). The Web-based method eases the social constraints of intersubjective interaction. As the responses are anonymous (element W1), there is no need to support the respondents' identity or role. Further, the toolset is designed to encourage respondents to let go of some of their analytical thinking and to apply creative problem-solving methods instead. This should decrease the impact of the existing cognitive constructs of the schemata (elements D3, D4).



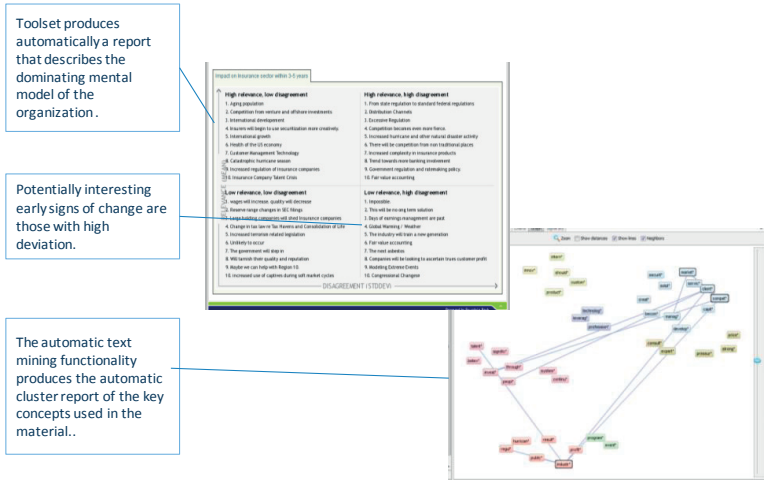
Picture 2: Participants provide the inquiry with detailed information about their backgrounds.

The nature of the participants becomes more diverse if a Web-based survey is used, because adding participants does not increase the cost (in most cases). The diversity of various mental models included in the survey can be increased by inviting participants with different backgrounds and roles and, in the best case, from different organizations applying different schemata. The detailed background variables allow us to report and analyze the perceptions among participants who have many external connections (hypothesis C6) and those who mainly interact internally with their own respondent group.



Picture 3: Respondents assess the material produced by their fellow respondents.

Depth of the filtering. As mentioned before, the tool promotes wide participation in sensemaking within an organization trying to handle particular problems related to element D2 and promotes the positive aspects of deep filters related to the element D4 of the filter construct. The toolset allows the depth of the filtering to be controlled through many processing rounds. It also allows management to keep the power filter (Ansoff 1979, 1990) open throughout the analysis phase and to postpone decision making if need be. This will delay the final impact of their decisions until the last phase of the process. A Web-based method operationalizes qualitative data into a quantitative format, so that the impact of the facilitators'/ researchers'/ management's interpretations are postponed until the final phase.



Picture 4: Grid on the left: The upper left hand corner lists the top 10 issues that all respondents agree on (high relevance, low deviation). This represents the dominant mental model of an organization. The chart on the right: the automatic clustering of the concepts

The toolset reports the typical features of the data assessed (i.e., the signals/comments with the highest importance on which most of the respondents agree). The list of signals (20% of the assessed material) with the highest importance/lowest deviation represents the *dominant mental*

model of participating respondents and thus the shared schemata of an organization. The toolset automatically produces a text miner report, showing the data clustered according to the most frequently used concepts in the material. The clustering is used as a basis for classifying and analyzing in detail the schemata found in the respondent groups.

How to measure the outcome?

To adjust the filter structure according to the needs of the research question, the data collection method has to be able to report and measure both the cognitive diversity (width) and the plausibility (depth) of the outcome of the scanning process. For this purpose, the toolset includes a specific reporting feature that reveals the structure of the schemata.

The diversity of the themes (number of comments within exclusive clusters of issues) is used as a measure of the cognitive width of the filter construct applied in the scanning process. In this study the thematic clustering of the narratives (data) collected was semiautomatic. The text mining tool (Hotho et. al 2005) collects the signals in key thematic-cluster concepts and automatically divides them into predefined (according to the typical corporate functions) categories.

The results are reported as a radar diagram as a visual representation of the structure. We call the shape of the radar diagram a "profile." The profile diagram describes the frequencies of signals in a cluster as a percentage of the number of signals collected. Comparison of the profiles of the groups that have used a different scanning process layout (filter construction) provides us with information through which we can test our hypotheses.

An example of cross-case comparison by using visual analysis

The method used for data collection facilitates comparison. In order to triangulate I also summarized results in an alternative way, as a visual report. Here I can simply compare the visualization of the different outcomes; the spider diagram of classified material.

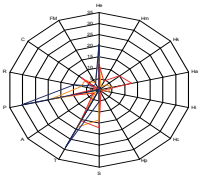
	Case IRO	Case GEC	Case GCC
Filter construction	Comparison between analytical FMEA risk analysis and web-based open scan in 2003 and 2004	Comparison between open scan and analysis (AandB) and focused scanning task (C&D)	Comparison of the outcome of the scanning process between different participant groups.
Cognitive variety			
Color codes	FMEA blue Signals 03 red Signals 04 yellow	A&B green C&D blue	Connectivity: high red, low lilac Intensity: high orange, low blue
Comments	Analytical and detailed FMEA process produced plenty of material on relatively fewer categories than open web-based risk scan.	Open scan produced more variety than focused scan.	Participants, who have more external contacts and a high intensity of interaction, produce more cognitive variety for the scan.

Table 1: A comparative report on the cognitive variety of the outcomes. Cognitive variety is measured by how many themes the collected material included and how many potential signals of change each of the clusters included. By measuring cognitive variety, we are able to compare the width of different filter constructs. Please note that, in the Case ICT, the results are confidential.

Information is a very specific resource of resilience. Complexity theories have revealed the role of information in system adaptation, yet there are a few practical tools for operationalizing this theoretical understanding for management purposes. The study presented in this summary and the published research papers attached focuses on information acquisition and sensemaking at the early phase of the strategy process. I will present an extension to the filter theory presented by Ansoff and Weick. In order to meet the requirements of a complex environment, the extension applies Complex Adaptive Systems theory to horizon scanning for detection of early signs of change in the operating environment. The results indicate that a flat and wide information filter produces a diverse set of potential weak signals of change and the deep and narrow information filter produces a shared perception of the environment. In the complex environment, connectivity of the organization supports early detection of change.

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