Early Warning Signals

Be ahead, Be ready

Insights about the use of early warning signals in Luxembourg's business community

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MINDFOREST
Managing Change

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(WW1 and WW2 Memorial)
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Reserch team

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This research project was headed by

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Dr. Matteo Forgiarini (MindForest, then LSB), Dr. Borna Jalsenjak (LSB), and Ivan D. Dogan were active in the project team for data collection and data codification.

Nico Hoffeld (MindForest) supported the data codification process.

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Outline of the White Book

Executive summary

In today's market, the frequency of change and the corresponding impacts on companies constantly increase. A reactive mode is no longer appropriate. However, discontinuities and strategic surprises do not emerge without warning. Early warning signals comprise part of the environmental scanning required for the elaboration of corporate strategy. However, the management of strategic surprises is still poorly addressed. The missing link lies in collecting data and "noises" emitted by the market or the macroscopic environment and their proper qualification as "early warning signals."

To fill this gap, it is first necessary to acknowledge that there is nothing "weak" in the signal itself. What is weak is the attention paid to the signal when it is still possible to make decisions, and avoid reactive modes endangering the business model. The qualification of "early warning signals" depends on the ability to work as a "theorist" who operates a searchlight. The question under analysis does not deal with "*knowing* the unknown"; it deals with "*navigating* the unknown." To take the future more seriously, it is necessary to acknowledge that there is no *right* or *wrong* foresight: there is only *better* foresight. Early warning signals serve the process of making the most appropriate decisions in due time.

This research acknowledges the relevance of "early warning signals" (EWS) in all companies, big or small. It improves the understanding of the ways of working about the "sensing" and "seizing" phases leading to business model adaptation and proactive management or risks and disasters. All categories of managers, and all categories of companies, scrutinize EWS. However, they do neither devote the same attention to signals, nor focus on the same categories of signals. Responses to the questionnaire and interviews explain that a broad range of ways of working exist in companies to manage signals. Pragmaticism prevails with respect to the identification of signals from all potential sources. Interviewees always stress the importance of active listening. Signal interpretation is more difficult than signal collection, and less complex that the appraisal of the subsequent actions for strategic adaptation. Ways of working for the "sensing" and "seizing" differ in SMEs, intermediate companies, and large companies. This project shows that the formalism of interactions increases with the size of companies, even though oral communication remains the most effective way to transport signals in all sizes of organizations. Direct interactions between senior managers in trusted and neutral environments represents a key success factor for the appraisal of signals to feed business model adaptation. Some initial conclusions are also available about the role of IT systems and AI for signal computation.

"The most important is not the information itself, or to find the information. It's to use the information in the proper way."

CxO in an intermediate firm

Foreword

In today's markets, the frequency of change and the corresponding impacts on companies constantly increase. A reactive mode is no longer appropriate. However, discontinuities and strategic surprises do not emerge without warning. Early warning signals (hereafter: EWS) are a part of environmental scanning required for the elaboration of corporate strategy. They represent meaningful leads that can be used to anticipate opportunities, risks, and threats. Companies need to have structures, processes, procedures, and competences in place to scan for and use early warning signals. Recent instances of strategic surprises and discontinuities for the Luxembourg business community can be found in the severe 2021 flooding, in the Covid-19 pandemic that led to 3 successive lockdowns between March 2020 and March-May 2021, and in the resurgence of war in Europe with the Russian aggression of Ukraine. Even if all these "events" do not compare, they all lead to paradigmatic changes in the business world that mandate adaptations in corporate strategies.

It remains challenging to make sense of strategic surprises and adapt strategies and ways of working in due time because this individual competency and this organizational capability relate to the paradox of "knowing the unknown." Managers must find the best way to cope with uncertainty and scan the environment to identify blind spots in corporate strategy: irrelevant, obsolete, incomplete, or incorrect assumptions about the environment.

Management research has oversimplified the topic in a three-phase framework based on signal collection, diagnosis generation, and strategy reconfiguration, leaving at best the operational execution of the new strategy to experts in change management but frequently deciding this issue. The missing link about early warning signals lies in the collection phase, which is supposed to feed the subsequent steps. It is poorly addressed. Research on this topic reaches a twofold conclusion. Missing those signals, being late in their reception and processing, or not being capable of launching corrective actions either drives companies into a crisis or prevents them from exploiting success potential. Increasing the awareness of the importance of early warning signals and providing tangible guidelines for using them could, conversely, help companies improve their competitiveness.

Even though theories in management science acknowledge the importance of "sensing" the signals that emerge in the external environment, such investigations do not directly analyze ways of working and practices concerning the collection and computation of those signals. This is precisely the topic of this white book. The question under investigation mixes the traditional approaches adopted to discussing external and internal factors of the firm. The external view usually focuses on the impact of external forces and macro-societal or macroeconomic drivers on corporate strategy. The internal view of corporate strategy usually

Photo 1
Grand ducal palace and Parliament

Photo © David W. Versailles

assesses strategic options considering resources available inside a firm, adhering to the “resource-based view” approach. Mixing the external and internal approaches situates the ability to make sense of early warning signals under the twin light of existing resources, enabling signal recognition and the congruence between the paradigm underlying corporate strategy and the content of the signals. The topic discussed in this white book about early warning signals fills a gap in the academic literature and shares the return on experience about how to best adapt corporate strategy to external (environmental, paradigmatic, societal) shocks.

In this white book, the first section introduces a series of conceptual references and identifies managerial issues about early warning signals, thus building a framework for field research activities. The following section describes the collection of data. Data collection articulated a series of (semi-structured) interviews and a questionnaire administered in the Luxembourg business community. The subsequent section displays the data collected in this project. It provides a series of diagrams and figures about the collection and computation processes linked to early warning signals emerging from the interviews and the questionnaire. The final sections discuss the data and identify the most interesting lessons learned about using and computing early warning signals in companies.

Adolphe bridge
and iconic Spuerkeess building

Photo © David W. Versailles

1. Searchlights versus sponges: How managers deal with early warning signals

It is always easy to retrospectively consider the relevance of warning signals. They are easy to qualify as "relevant" when one knows the end of a process, like someone who watches a movie for the second or third time and makes sense of all the leads included in the scenario because the end of the story is retrospectively available to interpret them as relevant.

The assumption underlying the notion of "early warning signals" is that disruptions and discontinuities do not emerge without warning. The challenge lies in identifying them in real time and putting ourselves in the decision makers' shoes.

This section will first discuss the notion of alertness when applied to "weak" signals and then examine the interaction between individual and collective processes to investigate this issue from the perspective of managers and decision-makers. The question under appraisal has not been studied through the lenses of cognitive sciences or psychology. The focus of this research is management science. The section then introduces the reference to a company's dynamic capabilities (through the "sensing-seizing-reconfiguring" phases) to bridge the discussion of alertness and EWS with the reconfiguration (or adaption) of business models and strategies.

In need of alertness: what is weak is the attention paid to the signal, not the signal itself

Even if companies elaborate on collective processes, developing alertness and attention to external signals always refer to individual mechanisms. Attention to signals depends on the consistency between signals and the individual cognitive map (or interpretation paradigm). It is a matter of knowledge leading to interpretation, not information or volume of available data. Human beings are usually happy when everything clicks together and tend to foster confirmation because it enhances their comfort zone. They typically miss signals that are totally out of the scope of their interpretation and filter out these signals. Cognitive maps are contingent on time, prevailing paradigms, social and value systems, "knowledge stock", stored mental models, and learning ability (Cevolini, 2016; Boisot, 1998). These elements still hold when individuals are supplemented (or "augmented") by observing systems and information technologies, i.e., when automated systems, machine learning, or artificial intelligence provide support.

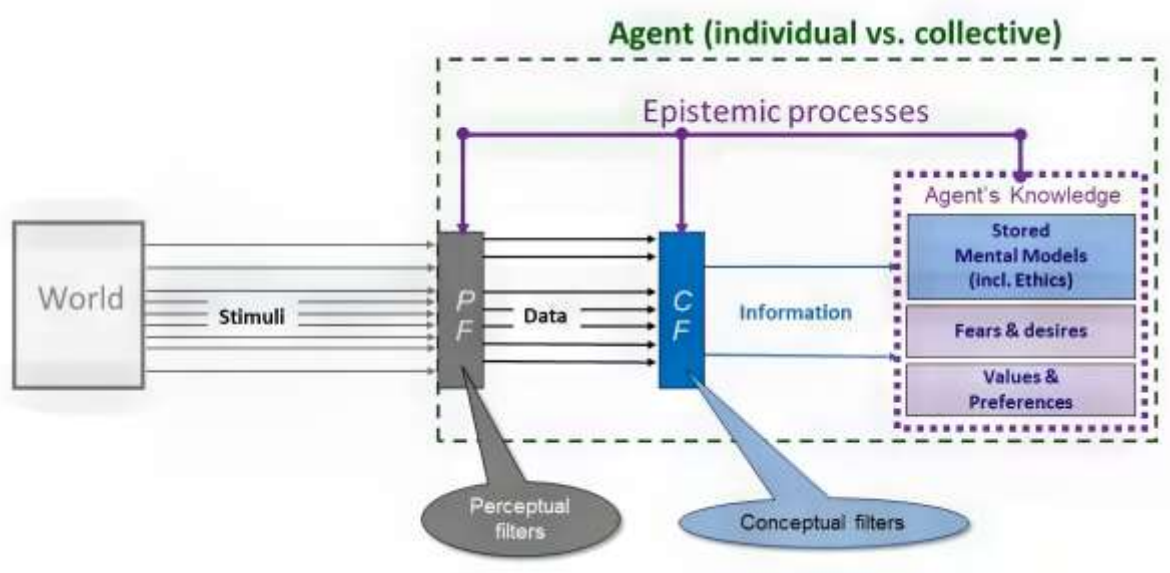
The notion of "weak signals" is used when links between signals (or "noises") and consequences are not automatically obvious or when signals represent leads towards disruptions to be computed in complex reasoning. This is an old concept made famous by Ansoff in 1975 that has come back to the forefront of management practices and management research again. The "weakness" of a signal lies

in the links between this signal and strategic/managerial issues: either they only have an indirect nature or poorly meet existing interpretation schemes, have indirect relevance, or suppose significant articulation efforts (Cevolini, 2016). "Weak" signals generate suspicions of inconsistency (and discomfort feelings) because managers and decision-makers experience discrepancies between an "environmental event" and their cognitive map. "Weak" signals are also often discarded without any appraisal because they are considered in isolation, while a broader picture would lead to further considerations. The difference between "weak" and "strong" signals results from interpretation issues. In a nutshell, the notion of a "weak" signal has nothing to do with the signal itself. The problem lies in the attention paid by observers or in their ability to make sense of "weak signals" providing early warning about eventual disruptions or disasters.

Boisot has proposed an analytical framework to understand the differences between stimuli, data, information, and knowledge (Canals and Boisot, 2004; Boisot, 1998; compare Figure 1). "Weak signals" belong to the category of "stimuli" in Figure 1. The discussion of "signals" relates to the presence of filters. The existence of filters explains why managers, decision-makers, or companies eventually face difficulties grasping the relevance of stimuli or data available in the environment.

The diagram shows very different stimuli available in the environment, but "perceptive filters" either do not allow to "sense" them as relevant "signals", or to singularize the relevant ones inside the massive volume of stimuli present in the environment. Consequently, stimuli are "missed" because perception is inaccurate.

Figure 1
Conceptual framework to differentiate between stimuli, data, information and knowledge (v.1)



Adapted from Boisot and Canals (2004), Journal of Evolutionary Economics

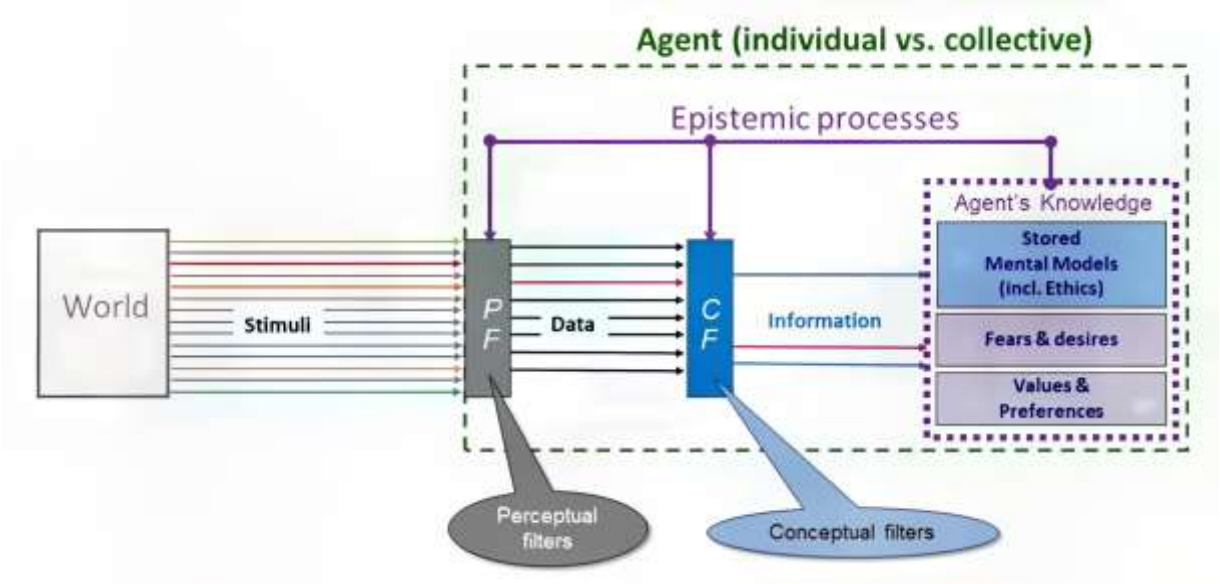
Perceptive filters are displayed in grey on the figures to show that only grey stimuli are grasped by the agent who "owns" filters for the grey color. The process leading to sorting stimuli by perceptive filters is, to a vast extent, developed thanks to reactions deeply embedded in individual behaviors and organizational processes.

The same mechanism applies to conceptual filters.

This generic term refers to cultural paradigms and the rules and ways of working installed in companies. Conceptual filters link formal rules and explicit knowledge assets prevailing in organizations (for instance, ways of working that focus on specific issues because of formal prerogatives inside a company). The blue color of conceptual filters displayed in Figure 1 shows that only "blue" topics are considered by managers or decision-makers operating the filters. One who oversees technological innovation or manages business development and client interactions will focus on this topic only.

The comparison between Figure 1 and Figure 2 shows the role of perceptive and conceptual filters. Figure 2 shows that "some" signals that are neither grey nor blue should be accepted even if they are "weak" because they provide "early warning": perceptive or conceptual filters should be updated in real-time to identify the red arrows presented in Figure 2 as relevant signals. In Figure 2, this is the case for the red arrows, which should be accepted first as relevant stimuli to build relevant information after careful examination.

Figure 2
Conceptual framework to differentiate between stimuli, data, information and knowledge (v.2)



Adapted from Boisot and Canals (2004), Journal of Evolutionary Economics

The computation process is not only based on perceptions. Once filters are passed through, signals are appraised against the agent's knowledge base that comprises stored mental models. This is the moment when agents actively compute available information. The knowledge base elaborates in parallel on fears, desires, values, and preferences that are socially constrained and partly framed inside companies. Values and ethical preferences explicitly translate corporate strategy into ways of working or interactions with clients. Behaviors are framed by rules and ways of working, a (formal) hierarchical repartition of prerogatives, and standard lists of tasks in job descriptions. Some aspects prevailing inside companies have a more informal nature: non-financial recognition of merits, rewards, or promotion patterns also follow rules that are not totally written but are nevertheless understood by everyone. External stakeholders and society frame other aspects of the knowledge base. Today, environmental and sustainability issues have gained importance, and the attention paid to stakeholders is greater in businesses than several decades ago.

Figure 1 and Figure 2 show arrows retroacting on perceptive and conceptual filters to update them and accommodate a new reference framework. In a company life, this might be the consequence of technological evolutions or innovation (for instance, with digitalization and the introduction of artificial intelligence) or the outcome of returns on experience shared after implementing a strategic change or confronting a disaster. This explanation of the mechanism of perceptive and conceptual filters confirms that the difference between "weak" and "strong" signals does not refer to the nature of the external world or the environment but to the observer (Cevolini, 2016). *It is a matter of "prepared minds".*

From individual to collective alertness: the need for multi-level investigations

Most uncertain events have a genuine aleatory nature, but it is possible to "imagine" future developments with a focus on appropriate signals (Packard and Klein, 2020a, b; Packard, Clark, and Klein, 2017). Turning away from probability language, approaches based on "possibilities" or on "corporate foresight" prefer the investigation of scenarios, thus building reference patterns suited for the analysis of external change (Fergnagni, 2022a). Scenarios empower minds to analyze potential change. The existence of "prepared minds" refers to the broad investigation of serendipity (Merindol and Versailles, 2020b, EGOS). "Preparation" makes it possible to work with employees, managers, and decision-makers about collective attention or alertness and to explain how to sense the different "signals" present in the environment (Teece, 2007; 2017).

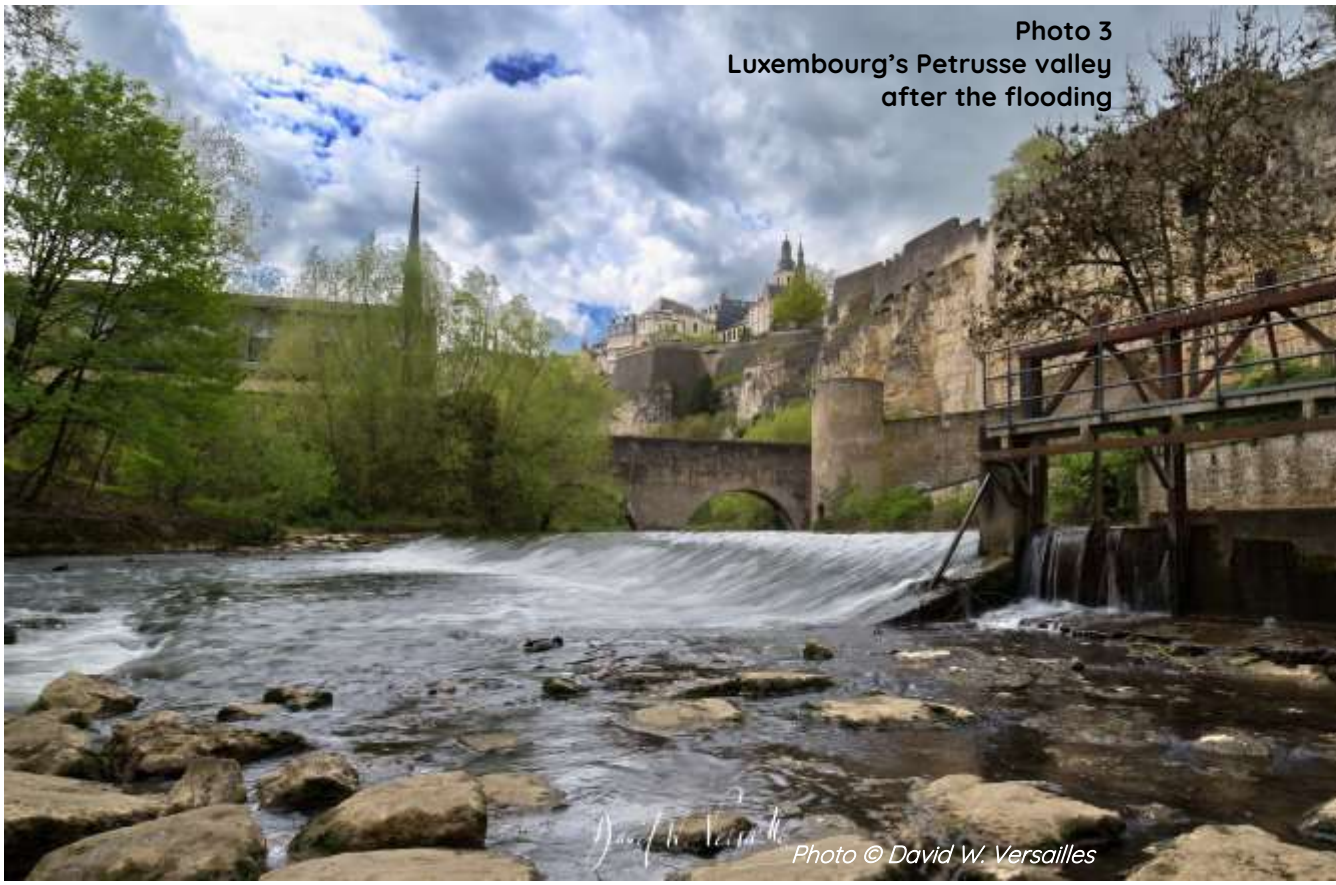


Photo 3
Luxembourg's Petrusse valley after the flooding

Recognizing signal relevance and identifying early warning signals refers to individual cognitive patterns, but their computation in companies remains a social process by nature. Cognitive aspects involve individual and collective components (individual cognitive efforts versus interaction with cultural and paradigmatic elements framed by organizations, companies, or society), while the articulation between "weak" signals and the elaboration of corrective plans and reconfigurations in corporate strategy incurs collective and organizational efforts. Several levels of interaction are required to recognize and manage early warning signals. Managers are at the intersection between individual and collective issues (Mérindol and Versailles, 2020).

Coordination and cooperation between all managers and decision-makers imply that competencies, knowledge assets, and actions are articulated together to build an outcome "greater than the sum of its parts" (Di Stefano, Peteraf, Verona, 2014; Felin, Foss, Ployhard, 2015). The only possible interplay between individual and collective aspects is located at the level of action: individual competencies and knowledge lead to individual action that combines with other individual actions to build collective outcomes. It is, therefore, necessary to identify how ways of working and rules prevailing in companies create the conditions for individual action and then lead to individual actions (Felin, Foss, Ployhard, 2015). Global outcomes cannot be assessed without considering the impact of rules, processes, and managerial inputs on individual workers and managers and of

performance indicators introduced by senior management. Specific responsibilities are assigned to each manager category (local managers, middle managers, heads of business units, etc.) to make groupwork effective, build collective competences, and create organizational knowledge (Mérindol and Versailles, 2020; Marrone, 2010). These elements at the collective level create the conditions for individual action and then lead to individual action.

The long list of domains potentially generating "early warning signals" explains that a combination of different people from different organization components contributes to analyzing the relevance of "weak signals." This imbrication of competencies and responsibilities indicates the need for multi-level analysis, targeting the combination of individual tasks (consciously or indirectly) operating in complementarity. Providing accurate analysis of these aspects in companies requires an ability to confront different sources of data and information inside the organization (because of the dispersion of knowledge). Providing accurate options to "prepare the minds" requires an ability to combine the conditions of individual actions and *jointly* open individual alertness to pay attention to "weak signals" and characterize them as *relevant* "early warning signals". These two sentences build the plan at a theoretical level. The practical challenge lies in the employees', managers', and strategic decision-makers' ability to cope with the complexity and uncertainty of the environment.

The question under analysis does not deal with "knowing the unknown"; it deals with "*navigating* the unknown" (Arend, 2020).

How is it possible to organize and compute these assessments in a company?

Here lies the real managerial challenge.

There is no magic toolbox to solve this issue, except that a combination of contributions from front-line employees, local managers, middle managers, and strategic decision-makers is required to make the appropriate decisions.

The bridge between individual and collective alertness requires explicit rules describing how data and information should travel throughout the organization. It is necessary to install a sort of information and cognitive "slack" to store signals (stimuli), data, information, and knowledge and make them available for further investigation.

Transporting these conceptual sentences into practice involves a long list of challenges because most activities are linked to formal and informal reporting and computation processes. It is also mandatory to put all appropriate/relevant people around the same table to make sense of the data (prior to them becoming accepted information).

How can early warning signals be transported into strategy and operations?

To understand the complexity of acknowledging signals as "early warning signals" and transporting them into decision-making processes and operations, it is relevant to picture a company as a sort of "organizational drivetrain" (Di Stefano, Peteraf, and Verona, 2014).

A company could be compared with a bike: managers sitting on it and pedaling it would "sense" the external "signals" before characterizing them as relevant. Here is a list of questions illustrating the (managerial) challenges to be addressed (Versailles and Foss, 2019):

Who is "operating" the eyes orienting the "scanning" process that mimics the detection of "noises" while riding the bike? Where are the sensors? If employees are only pictured as the back wheel, how is their feedback considered when analyzing "warnings"? Is it normal to figure out contributions by front-line employees and local managers as some deterministic consequence of the pedaling performed by "someone" who is also "driving" the bicycle? Who is activating the brakes? Who is pedaling? Managers and strategic decision makers, or frontline managers and employees? Who is activating the crankset and the front and back gears?

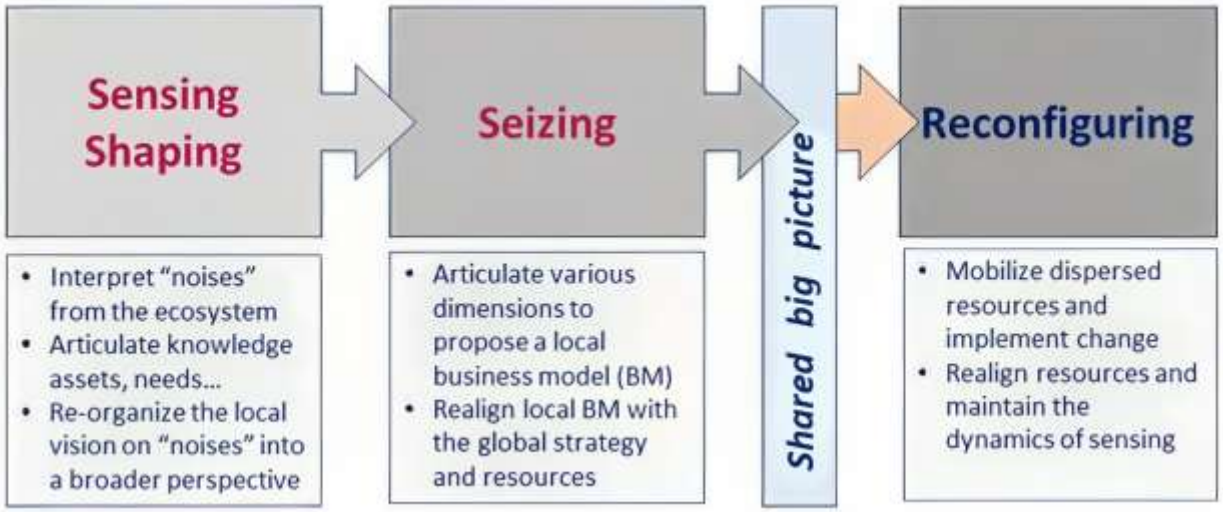
Is business model reconfiguration or adaptation affected by the challenges presented by the environment when dealing with the bike's speed, the change of front and rear gears, or a change of direction? Are strategic reconfigurations incurring technical reconfigurations for the bike? Who is handling the handlebars and negotiating turns?

Where is the necessary evolution of the "conditions of individual action" on the bike (for instance, an evolution of norms, rules, and routines)? Is the activation of the derailleur an image for change management or managerial contributions to operations? Is the bike rider sitting alone on the saddle? Should the analysis consider that each business unit represents a specific bike?

The questions listed here show the managerial challenges to be addressed when articulating alertness at individual and collective levels, thus contributing to building a bridge between the bike rider's sensors (the eyes and the feeling of air flowing over the skin) and the group. When computing the appropriate "signals" in using individual and collective perceptive and cognitive filters, firms can adapt, reconfigure their internal processes, reshape their portfolios of services/products to best adapt to market conditions and competition, and thus defend their competitive advantage.

To work on these aspects, management research has produced an analytical framework comprising three distinctive steps, respectively coined as "sensing",

Figure 3
Early warning signals resituated in the dynamic capabilities framework



Adapted from Teece 2007, 2017; Mérindol and Versailles, 2020.

"seizing" and "reconfiguring" in the approach of dynamic capabilities consistent with the micro-foundations approach (Teece, 2007).

The "sensing" represented by the first building block of Figure 3 is very close to the already described debate about the content of perceptive and cognitive filters making sense of the market "noises". Their correct recognition as early warning signals thus constitutes the starting point of the journey towards the reconfiguration process.

The "sensing" box should be complemented by the different arrows presented and discussed in Figure 2 to filter the stimuli and transport them first into decisions (with the "seizing" and "reconfiguring" phases) and then into the improvement of the perceptive and cognitive filters.

The second block of activities, coined as "seizing," relates to interpreting "noises." Once signals are acknowledged as relevant inputs, the "seizing" elaborates a list of options leading to decisions about corporate strategy. During this phase, significant efforts are devoted to the alignment of perspectives and the progressive elaboration of a "shared big picture," preparing simultaneously for the elaboration of strategic reconfiguration and the discussion of the acceptability of the subsequent change management.

The third block focuses on" reconfiguring" activities and implementing change, covering all dimensions of the service/product portfolio, operations, investment funding, and constraints incurred by cash and working capital management. Here, the eventual realignment of resources is justified by the evolutions that will emerge in the future.

Different attitudes will emerge depending on the culture prevailing in each organization or depending on the sector. Some economic agents exhibit a very proactive attitude and always commit to change before it is too late, while others do not see the need for change until something is broken. Recognizing EWS as essential and relevant signals remains a managerial process that introduces a challenge. Some actors in a company will discard the discussion of EWS during the "sensing" phase (because of irrelevant perceptive or conceptual filters). In contrast, others will prefer to discard it during the "seizing" or "reconfiguration" phase (because they belong to a culture procrastinating about business model adaptation).

The ability to identify, analyze, and take advantage of EWS represents an actual component of a company's core competences (or dynamic capabilities) and an essential driver of the company's competitiveness. However, from a practical perspective, or a decision maker's point of view, the literature is silent about variables, behaviors, processes, ways of working, and repartition of activities explaining how these aspects are concretely addressed in companies.

This need for further investigation applies to the three stages of the dynamic capabilities framework and, most notably, the articulation between contributions made by staff members, employees, and managers from all organizational layers to the three boxes pictured in Figure 3.

Decision makers as theorists working on change and business model adaptation

Business model adaptation, business model innovation, and change management operated at the strategic level represent complex undertakings (Foss and Saebi, 2017). Still, practitioners and academics have already proposed strategies to work on these topics. Nobody asserts that the seizing and reconfiguring sequences are easy to understand. The elaboration of a *shared* big picture is among the most significant challenges inside companies. Inquiries about the management of the sensing phase still represent a sort of magic box, even though scholars acknowledge that it does not operate randomly. Filling these gaps is precisely among the purposes of this research project about early warning signals.

Managers often limit their actions and decisions to resources and capabilities that they already possess. This approach is frequently translated into replicating existing paradigms and current business models without considering the evolution of the business environment. The discussion of strategic discontinuities and strategic surprises requires another perspective that should focus first and foremost on the ability to anticipate the next moves and on the ability to react "in due time" about forthcoming eventual disruptions, whatever the disruptions relate to external shocks (Covid pandemic impacting the sustainability of the supply chain, or

flooding destroying production resources), to technological evolution (e.g., generative AI) or new competition endangering incumbents. Optimizing the use of existing resources and capabilities, or "pivoting" to use them differently, only represents one aspect of the debate because the best possible exploitation of resources and capabilities frames the lenses through which reality is appraised.

Managing strategic surprises requires coping with a changing environment thanks to the adapted filtering of market "noises" and external stimuli. The traditional "resource-based view of the firm" (Barney, 1991), therefore, transforms into the "theory-based view of the firm" (Felin and Zenger, 2017; Felin, Kauffman, and Zenger, 2021). This approach investigates potential scenarios for the future as well as the external conditions framing the sustainability of the competitive advantage, for instance, regarding the components in the supply chain or the determinants of effective demand. This never-ending journey is based on assumptions, investigations of the environment, and scenario-building. *The journey is more important than the destination.* To navigate uncertainty and potential disruptions, companies need a dialog between, on one the hand, signals collected about any part of the business environment and of the organization and, on the other hand, the shared big picture that sums up the existing business model, and orient eventual adaptations of the strategic directions. This dialog is based on awareness. It does not operate at random, like some "blind" trawling. It can only become effective when operating like a searchlight (hence, the words "search" and "theorists" in titles and articles by Felin and his co-authors (Felin and Zenger, 2017; Felin, Kauffman and Zenger, 2021). Therefore, employees and managers need to behave like searchlights, not just waiting for data and information to impact them. If they only act as sponges, the possibility of being overwhelmed by the volume of data/information is significantly high. The main issue will then be overlooked: the critical point is to

Photo 4
Pfaffenthal and the Grand Duchess Charlotte Bridge

Photo © David W. Versailles

separate the wheat from the chaff and enhance it with other ingredients (namely, data, information, and knowledge) to cook relevant decisions for a company. The words “theorists” or “searchlights” stress the importance of active behavior toward accurately selecting relevant data and information and the capacity to build scenarios and decisions.

Nobody asserts that operating the sensing-seizing-reconfiguring sequence goes without challenges. Many different dimensions should be considered concerning the elaboration of a shared big picture, the preparation for reconfiguration (the so-called “agility” of the business model and the elaboration of readiness for change), and change management incurred by reconfiguration itself. The mandatory step leading to an eventual adaptation to strategic change is in the articulation between all phases of the process, upstream during a data collection phase that is most often ignored or mishandled in organizations, and downstream during seizing and reconfiguration phases where change management is usually managed sequentially and independently from the data collection phase. The use of early warning signals as relevant inputs for corporate strategy echoes ancient debates in philosophy, economics, and management: the objective of working with early warning signals is not to “manage *the* future” (singular). Signals serve to build representations of potential long-term futures (plural) with scenario-based analysis (Fergnagni, 2022 a, b). Future scenarios are (collectively) created during corporate foresight projects as a set of plausible states to be worked with and as a tool to achieve outcomes in the present. This includes the discussion and enhancement of mental models on (individual) creativity, on (collective) flexibility, and on the analysis of routines and ways of working in companies (Boisot, 1998). The future is problematic, unknowable, uncontrollable, and, thus, cannot be “managed”. To take the future more seriously, it is necessary to acknowledge that there is no *right* or *wrong* foresight: there is only *better* foresight. In this framework, early warning signals serve the process of making the most appropriate decisions in due time (Wenzel, 2022). Therefore, the question under investigation is about the tools pertinent to collectively “navigating the unknown” and the adaptation to the constantly evolving environment and its disruptions.

Kirchberg skyscrapers and Philarmonie

Photo © David W. Versailles

2. Demographics of interviewees and respondents

The project started in June 2021 among the Luxembourg business community. Luxembourg's business ecosystem is interesting because firms have retrospective experience with the flooding that occurred in July 2021 in Luxembourg and neighboring regions in Belgium and Germany, as well as with the COVID-19 pandemic, thus leading to improved awareness for business model adaptation.

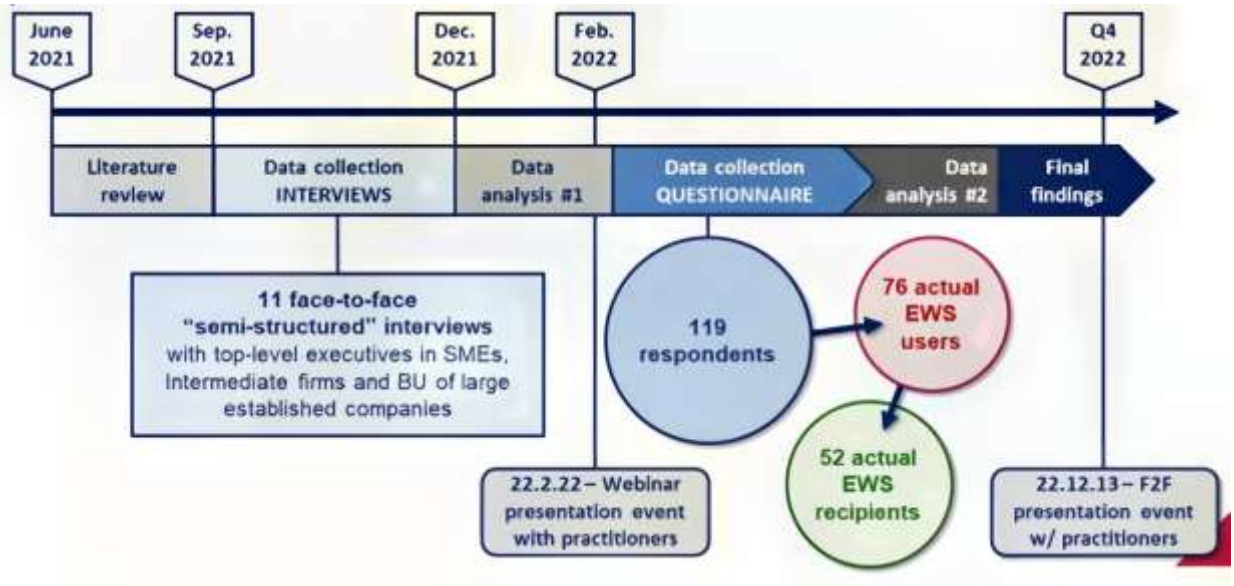
Luxembourg's business community also operates with a cross-cultural workforce (3 borders region; a significant number of foreign residents; 250,000 trans-border daily commuters), thus reshaping the reference to "localism" and mandating a zoom out from personal cultural references.

Data collection articulated two phases: semi-structured interviews and a questionnaire. Both activities were operated in the Luxembourg business community after the end of the COVID-19 pandemic.

Figure 4 provides an overview of the research protocol and the three subsamples in this investigation.

Eleven interviews were conducted between September 2021 and January 2022. Different categories of managers (owners, CxOs, and middle managers) were interviewed in various categories of firms (startups, SMEs, Medium-sized companies, and global business units from international firms). Interviews deliberately did not focus on front-line employees. The codification of interviews was 80% completed before starting the questionnaire design. As illustrated in Figure 4, a

Figure 4
Overview of data collection protocol



Source: EWS project management

specific webinar was organized with interviewees and practitioners from the Luxembourg business community to present interim results and collect feedback at the end of the interview phase.

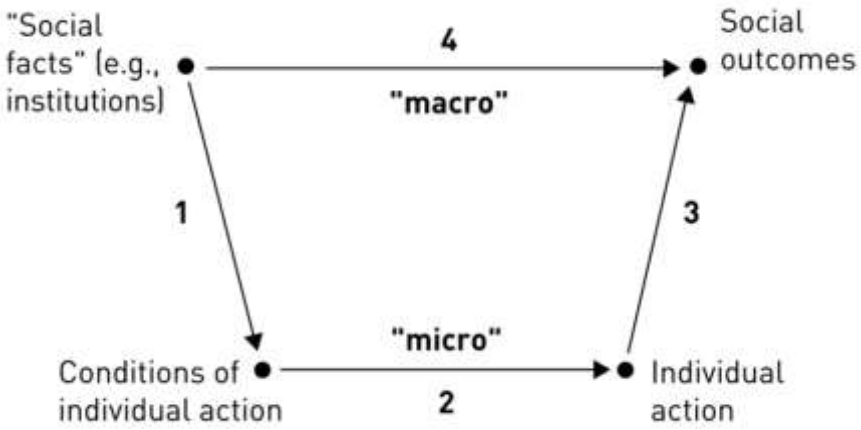
The questionnaire was administered through SurveyMonkey and disseminated through social media (LinkedIn) to the local business community. It included explicit questions about the respondents' locations and citizenship. Specific invitations to respond were listed in newsletters sent by the Luxembourg Chamber of Commerce and other local communities. Questionnaire responses were collected between Feb. 22nd and June 26th, 2022. Microsoft Excel and R were used for data analysis. The questionnaire was designed in English, as this language is consistent with business practices in the Luxembourg community. At the end of June 2022, a decision was made to stop the collection of responses to the questionnaire because the initial target of respondents in the local business community was not generating further responses despite additional efforts.

Unpacking multi-level analysis with different categories of employees and managers

The data collection process aligns with the precepts of multi-level analysis (Coleman, 1986; Versailles and Foss, 2019) to analyze the journey towards collective outcomes with the management of EWS inside companies. The diagram (now famous as a sort of "bath tub", see Figure 5) shows the interplay between the different "layers" that combine to generate collective outcomes.

These steps are required to understand the necessary bridges between individual isolated actions and collective outcomes: the conditions of individual actions, individual action itself, and reporting processes existing in companies to ensure that decision-makers take advantage of EWS to build decisions. Collective alertness requires an assessment of all aspects pictured on the lower part of the diagram because it is impossible to elaborate decisions without considering the different activities performed at the nodes respectively labeled as "conditions of individual action" (between arrows #1 and #2) and "human action" (between arrows #2 and #3) to ensure that frontline employees, frontline managers, and middle managers commit to collecting EWS and enable this data or information to travel via the organization towards decision-makers. Initial social and institutional conditions prevailing in the organization frame the potential for alertness along with values, ideologies, and paradigms for thought and action. Rules and managerial inputs frame the conditions of individual action about alertness at each organizational level, thus drawing a series of ways of working, attitudes, behaviors, contributions, incentives, and rewards.

Figure 5
Coleman's bath tub



Source: Felin, Foss, Ployhard, 2015: 591; Versailles and Foss, 2019: 22

Individual action itself can be "unpacked" into several aspects (*the list is not exhaustive*):

- Individual evaluation of internal and external signals collected "into the wild",
- Decisions about signal transfers throughout the organization,
- Decisions about eventually using the signal evaluation's outcomes to adapt operations or the business model and thus reconfigure the company.
- Decisions about the contents of change management after reconfiguration decisions.
- Individual decisions to accept, block, or foster change management because the relevance of signals is not (individually) acknowledged.

Social and collective outcomes cover any reconfiguration of an organization, such as the sustainability of a business model and the associated change management.

The collection of signals into the wild illustrates the difficulty linked to the volume of potentially relevant sources: all aspects appraised with the internal and external analysis of the firm are potentially applicable. They may emerge from interactions with clients and suppliers or from the investigation of market conditions (Porter, 1991). Other relevant signals relate to internal organizational resources and, most notably, human and financial resources, as well as all capabilities present in an organization. The aspects to be covered in this second category are present in the traditional agenda of the 'resource-based view' of the firm (Barney, 1991) and its recent expansion (Helfat et al., 2023). The approach presented in this

document aligns with the main conclusion of the "resource-based view approach". All signals available in the environment are equally available to all companies in the business community. Only the existence of distinctive internal competencies (as a reference to individual capabilities) and internal competences (as a reference to organizational and collective processes "making agency" or making a company more than the sum of its parts) justifies that specific companies will eventually generate greater value from noises and signals than others. These points were addressed with interview questions and investigated in the questionnaire.

Variety of respondents in the survey

Three subsamples were installed to analyze the data collected with the questionnaire. The subsamples were defined after studying responses.

Subsample A is built with the 113 fully responded questionnaires collected from the 119 respondents. The questionnaire first introduced 12 questions to qualify the nature of the company, its location, size, and sector, the respondent's role and responsibilities, and the nature of the business (B2B versus B2C).

119 respondents took part in the investigation, with 113 fully responded questionnaires, considering the existence of conditional embranchments in the questionnaire format. 89 responses were collected from people claiming their direct involvement in Luxembourg's business community. 14 responses (11.76%) were provided by respondents from the rest of Europe and 16 (13.45%) from the rest of the world. It is not easy to assess whether these 25% of respondents are totally out of the scope of the analysis or residents spending short periods in Luxembourg for other purposes (for instance, education) or before emigration.

The repartition of respondents in economic sectors reflects an accurate representation of Luxembourg's business community, with 21% from financial and insurance activities, 17% from manufacturing sectors, 15% from information and communication, and 12.6% from other services. It should be noted that 4% of the respondents are from the construction sector, and 3.36% are from education. It is also worth pointing out the unexpected under-representation of the healthcare and social work domain, with only 2.5% of the responses.

Only 12.61% of respondents work in large companies, 33% in intermediate firms, and 47% in SMEs. This response is cross-validated with answers provided for the volume of annual revenue and FTEs (even though 6.72% of respondents do not know the answers to the question about the volume of FTEs in their companies and 30% about their total revenues).

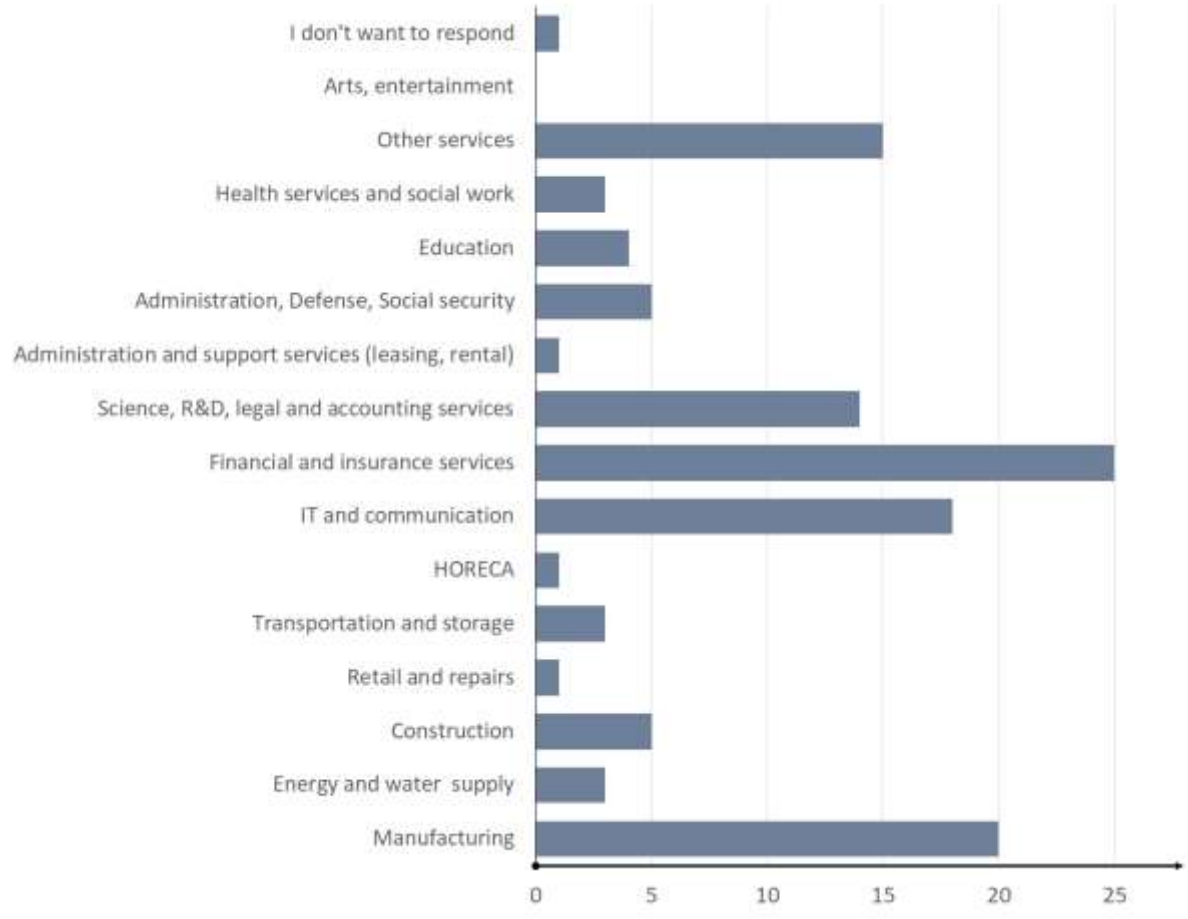
Most of these organizations have the legal form of a private company (32.77% and 1.93% for SA and SARL, respectively). Non-profit organizations represent 10% of the total. The other 11.7% covers other legal forms used by private companies

(SNC, SCS, CS, IF or SOPARFI). 6.7% do not know the answer to that question or do not want to respond, and another 6.7% consider this question as "not applicable" to their case.

53% of respondents have a position in a company that is part of an international group, while 40% have positions in independent companies. Only 13.45% of respondents have a sole focus on a B2C portfolio of activities. 53% of respondents specialize on a B2B portfolio, while 13.45% have a twin activity for B2B and B2C. 51.26% of respondents directly interact with the final customer (while 46.22% never interact with them).

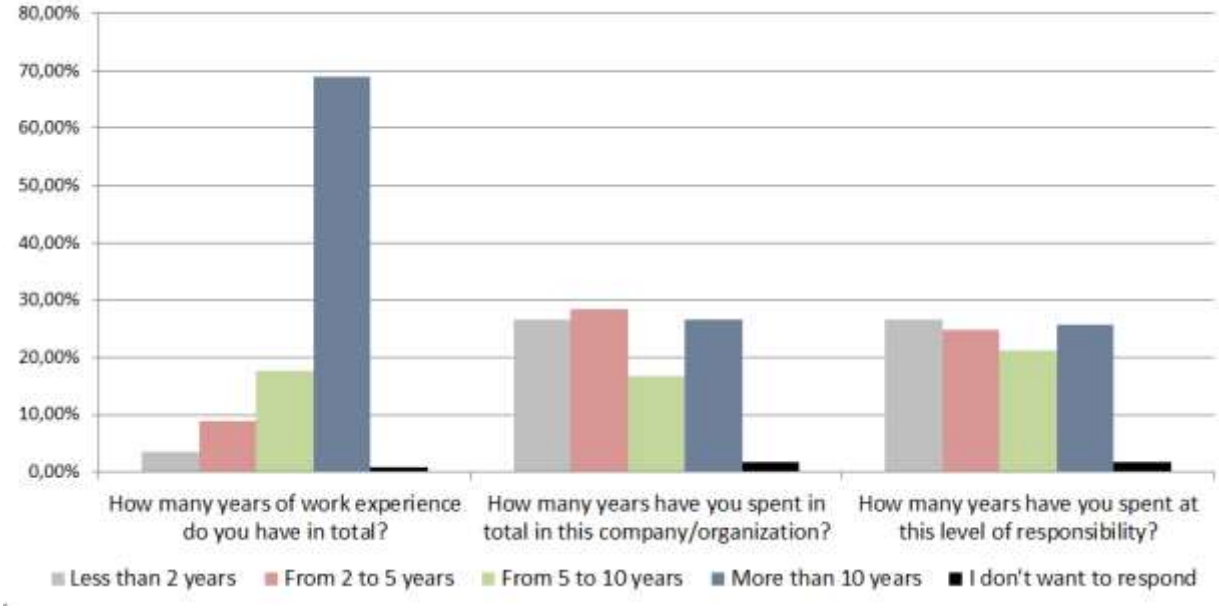
The sample covers two main categories of roles in the organizations (see Table 1). The largest number of respondents are middle managers and operational managers (50% of the total, with 56 responses). Front-line employees issued 20% of responses, and 40% by people active in the strategic levels of the organizations (owners, administrators, board members, or CxOs). 13 respondents did not answer that question.

Figure 6
Sectoral attribution of respondents (sub-sample A, 119 responses)



Source: Question 1 of the questionnaire

Figure 7
Demography of respondents by personal experience



Source:: Question 10 of the survey

Table 1
Demography of respondents by position and rôle (sub-samples A and B)

Answer Choices	Sub-sample B		Total sample A	
Owner	15.79%	12	10,92%	13
Administrator and Board member	2.63%	2	1,68%	2
Managing Director or CEO	13.16%	10	10,92%	13
CxO	5.26%	4	5,04%	6
Middle manager	28.95%	22	27,74%	33
Operational managers or supervisors	17.11%	13	16,81%	20
Front line employee	11.84%	9	15,97%	19
I don't want to respond	5.26%	4	5,88%	7
Sub-total = Answered	**100.00%**	**76**	**94.96%**	**113**
Skipped	0.00%	0	5,04%	6
TOTAL	**100.00%**	**76**	**100.00%**	**119**

Source: Question 9 of the survey and investigations developed to qualify sub-samples A and B

Most respondents demonstrate long experience and significant stability at their level of responsibility and in their current organizations (compare Figure 7). This response is consistent with the high number of respondents with senior levels of responsibility in the sample and the high number of small and intermediate companies.

Of the 113 fully responded questionnaires, 76 respondents declared themselves current EWS users. These responses build subsample B. 32 questions made it possible to assess the companies' use of early warning signals. The questions investigate the sources of EWS, the nature and frequency of EWS use, the content and focus of EWS collected and analyzed in the companies, the associated analysis and decision processes, the satisfaction with EWS processing, and the subsequent uses for managerial or strategic decisions.

Subsample C focuses on the 52 respondents in subsample B who receive EWS from colleagues, subordinates, superiors, or third parties. With a conditional branch of the questionnaire, five specific questions inquire about the contents of received reports, discuss what respondents do with these reports, and how they take advantage of reports about EWS to analyze risks or prepare decisions.

Neumünster Abbey and the Grund after recovering from the flooding

Photo © David W. Versailles

3. Early warning signals collection and computation processes

The questionnaire cross-analyzed different categories of signals for the different seniority levels, discriminating between owners, administrators, and board members, managing directors, CxOs who do not have any of the previous positions at the same time, middle managers, operational and supervisory managers directly in contact with front line employees, and front-line employees.

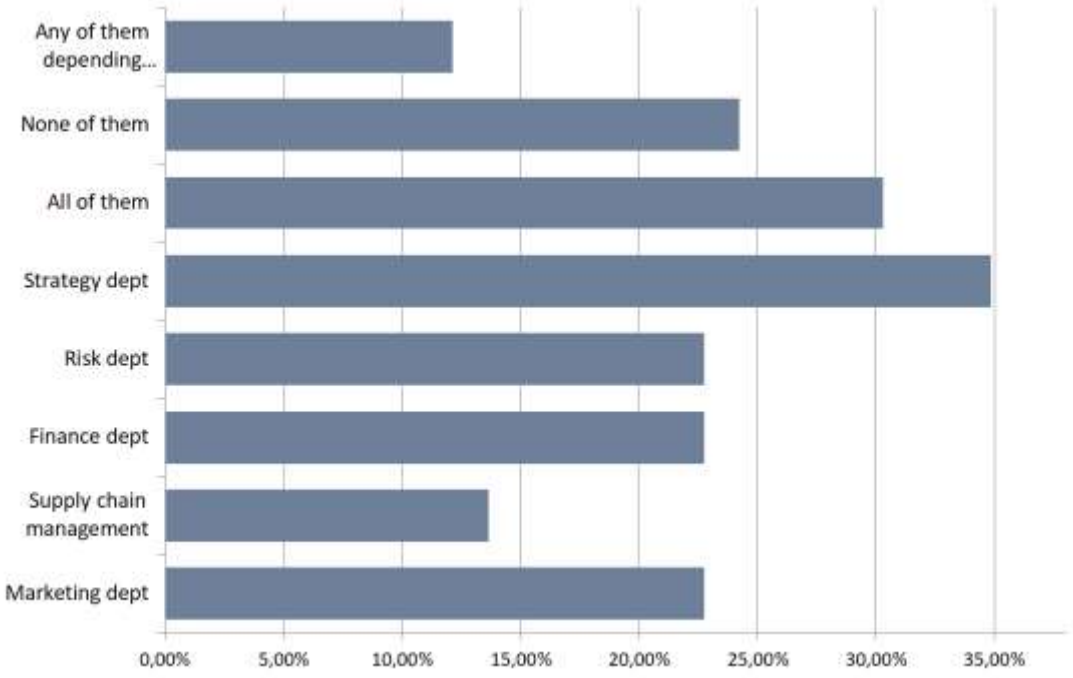
As a standard practice in a questionnaire, specific modalities were also proposed for those who did not want to respond to that question, those who have "no idea" or think that the question does not apply to them, and to ensure that blank responses could not be mistaken for the previous three categories

Internal and external sources of signals investigated in companies

The questionnaire introduced questions about the departments in charge of collecting signals and whether it is a task assigned to a specific department. The questionnaire has identified three interesting modalities when respondents tick "all of them", "none of them", or "any of them, depending on a board decision". More than 30% of respondents identify that all departments in a company are tasked with signal collection, but 24% of respondents document that it is not assigned to any department. This contrast shows the variety of attitudes towards signals and the variety of configurations in place regarding the collection/ computation of signals. More than 12% still wait for a board decision to organize activities about signal *collection*, without even anticipating the next steps related to deep dives or signal computation.

Unsurprisingly, the department in charge of corporate strategy attracts the most significant part of tasks when discussing the collection of signals because business model adaptation and strategic adjustments are by nature prepared by this department. When they have autonomy with respect to the department in charge of strategy, the department in charge of risk management may also oversee signal collection. The department in charge of marketing traditionally has responsibilities to anticipate the evolutions of clients' behaviors; it is therefore tasked with specific issues regarding market trends and signals incurred from the analysis of clients. Similarly, finance departments are present in the signal collection, most notably focusing on macroeconomics and public policies. Firms focusing on supply chain management generally have a department that also operates the associated signal collection. They find an essential part of the signals they want to scrutinize in the suppliers' activities and the logistics of bringing supplies to their facilities. Better qualification of the data presented in this response makes it easy

Figure 8
Are specific departments in charge of collecting signals?



Source: Question 27 of the survey

to understand the high correlation between company profiles and industrial sectors and the nature of departments in charge of signal collection.

The interviews also inquired about the *sources* of signals collected by companies.

Responses characterize a significant heterogeneity and show an unexpected diversity. They show that pragmaticism and personal habits prevail in the selection of sources. Responses show a significant correlation between the nature of respondents' jobs (marketing, sales, finance, etc.) and their typical sources for EWS.

Most interviewees do not introduce any ranking between sources. The ones who propose rankings indicate the prominent importance of data collected from clients and end-users. However, lists are hardly structured, and respondents only provide an unsorted series of items. These items are sometimes consistent and focused on the same topic. They are usually heterogeneous for each respondent. Lists offer evidence that the diversity of sources results from the respondent's brainstorming when dealing with the questionnaire. Considering this heterogeneity and the absence of structure proposed by the individual respondents, it does not make sense to suggest any graphic presentation or to develop statistics about the lists.

The list below tries to group responses collected during interviews in a thematic way:

- Peers and other market players, industry meetings, competitor analysis, business partners
- Family and friends, acquaintances,
- Shareholders,
- Consultants, think tanks, analysts, industry reviews, industry news, opinion leaders, insight reports, and any other intelligence tool,
- Innovation dashboards,
- Market trends, Economic forecasts, Marketing forecasts: Financial and non-financial macroeconomic variables (exchange rates, interest rates, etc.); Raw materials prices
- Professional organizations
- International (EU) and national institutions, regulators, central banks; Legal texts before final votes in Parliaments (thus introducing leads for lobbying, or "institutional relations"),
- Banks, law firms,
- Specialized media (Bloomberg, Meltwater, Factiva, Refinitiv, Oxford Economics, Hearsay, Financials, etc.), newsletters
- General press, daily press briefing, Google news, online search engines, information TV channels,
- Social media, Linked-In groups,
- Research papers, scientific publications
- Clients and end-users (even when introducing complaints), behaviors, testing surveys,
- Suppliers
- HR audits, HR partners, and data about the job market
- Colleagues, employees, upper management, Knowledge management tools inside the company,
- Operations: Operational incidents RCA, operational KPI.

Who pays attention to signals in the sample of respondents?

Except for one CEO in a local public company who bluntly explained that he does not pay any attention to the collection, computation, or discussion of early warning signals, all interviewees and respondents say that EWS represent relevant data. This CEO probably (blindly) relies on subordinates or his supervisory administration to do the job for him.

In the total sample (A), 87,61% of respondents claim they pay attention to signals and signs indicating a change is ahead. This corresponds to 99 persons out of 113 valid responses. Six respondents skipped the question and dropped out of the whole questionnaire at this early stage. With the exceptions of a CxO and a managing director, respondents who claim not to pay attention to early warning signals are all employees or middle managers. The CxO works in an "intermediate" size company (between €50mio and €1.5bn of revenue) from the textile industry focused on B2B business that is also a subsidiary of a multinational. The managing director works in a Luxembourg-based SME from the construction sector. All other respondents who do not use EWS have positions in diverse company sizes and sectors (ICT, catering, etc.).

Subsample B is built with all 76 people, demonstrating that they concretely use signals (63.8% of sample A). Subsample C is designed for 52 persons who receive signals from colleagues, subordinates, or "third parties" (43,7% of sample A; see Figure 25). All explain that signals are very relevant for their organizations.

Respondents who gave positive answers have positions in all categories of companies, even though the categories of medium-sized and intermediate companies are more represented than the others, with 19.19% and 33.33% of the sample, respectively. However, the number of respondents with positive answers is inconsistent with the data collected with interviews showing more nuanced behaviors and less solid "yes". Interestingly, the proportion of positive responses can be classified into four different categories:

- Owners, managing directors, board members, CEOs, and administrators for 34.41% of the total;
- Middle managers for 31.18%;
- Operational managers and supervisors for 17.20%;
- Front line employees for 17.20%.

These responses are interesting because they confirm that collecting early warning signals represents a task not reserved for a series of "happy few" in charge of strategic decision-making inside companies. All categories of managers and employees inside companies share this task. However, the sample of available data does not make it possible to explain whether respondents present in the sample are representative of the global situation.

How much time and effort do respondents devote to signal collection and computation?

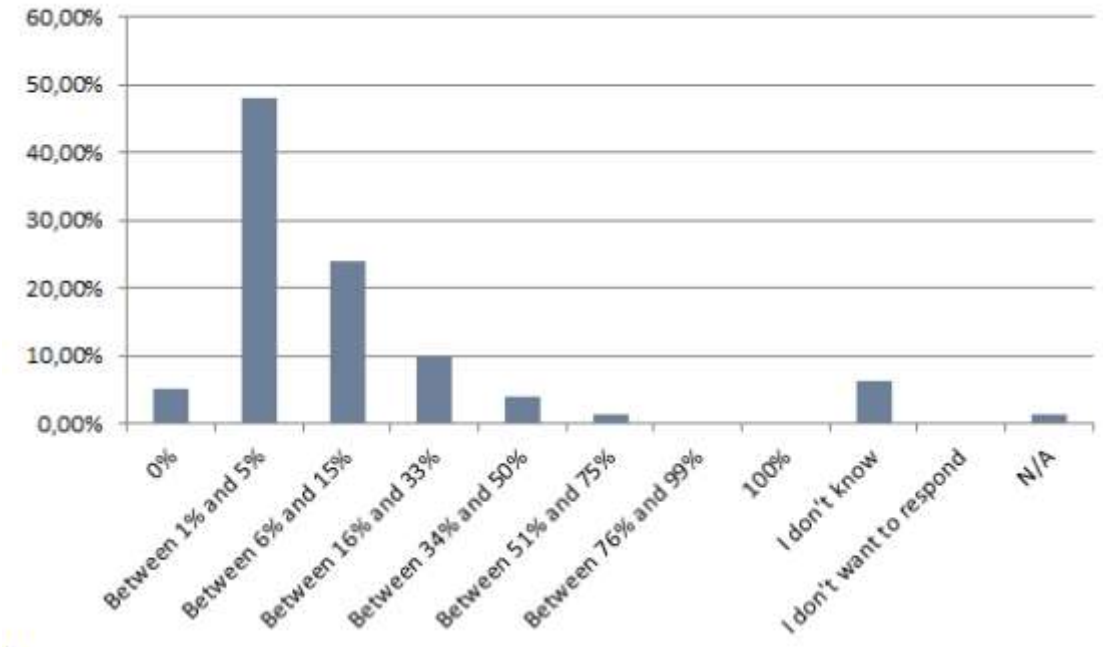
During the interview phase, data was mainly collected from senior managers and executives who were convinced by the relevance of "handling" signals. This is still true among the senior managers who responded to the questionnaire. However, the questionnaire also revealed that signals are also conveyed by colleagues, subordinates, and "third parties". When inquiring about signal collection in the questionnaire, the proportion of respondents with positive answers is inconsistent with data collected during the interviews, showing more nuanced behaviors towards collecting and using early warning signals. Responses collected via the

questionnaire show a shift towards an atypical volume of positive responses about the relevance of signal collection and computation compared to data collected during the interviews. Almost all respondents to the questionnaire disclose the significant importance of signals. The comparison between the samples (interviews versus questionnaire), therefore, suggests a bias for the questionnaire: it seems that it was mainly responded to by people who already have an interest in signals.

Respondents who responded to their total effort about signal collection ("sensing") and/or computation ("seizing") have their positions in all categories of companies. They also belong to all categories of people working inside companies, from owners to front-line employees. Responses show that the collection and computation of EWS are not reserved for a series of "happy few" in charge of strategic decision-making inside companies: EWS collection and analysis are also performed by all categories of managers and employees. The analysis of EWS collection efforts shows that almost 50% of respondents belonging to subsample A devote between 1% and 5% of their total workload to this task. More than 20% of them devote between 6% and 15% of their workload to EWS, and 10% between 16% and 33% of their time and effort to this activity (see Figure 9).

Out of the 99 respondents claiming to pay attention to early warning signals, only 75 respondents describe the volume of effort represented by these activities in

Figure 9
Signal collection effort vs. total workload for the 79 respondents in sub-sample A (total = 119) who did not skip the question



Source: Question 14 of the questionnaire

their total workload. Thirty-eight respondents evaluated the total effort devoted to EWS collection as being between 1% and 5% of their workload; 19 respondents assessed it as between 6% and 15% (26%). Further 12 respondents claim to devote between 16% and 75% of their time to EWS collection, but these people seem to have specific positions. It should be noted that the respondents who dedicate such a high proportion of their total workload to EWS collection are not all positioned in companies as strategic decision-makers. Some of them are also operational managers and front-line employees.

The table below describes daily, weekly, or monthly volumes of effort associated with EWS data collection. Responses listed in the table do not reflect a consistent view of the total volumes of effort: responses typically show that respondents did not compute the concatenation of daily efforts into weekly and monthly totals. One person who claims to spend 31 to 60 minutes daily should also identify that monthly efforts devoted to EWS data collection are superior to 120 minutes. This inconsistency shows that data collected for these questions should be considered for this question with precautions.

The questions about volumes of effort and proportions of total effort devoted to EWS data collection generated 40 blank responses in the questionnaire and six reactions of the type "I don't know". This volume of blank responses is consistent throughout the questionnaire, in all sections dedicated to the effort devoted to EWS collection and use of subsequent information.

Table 2
Time devoted to signal collection

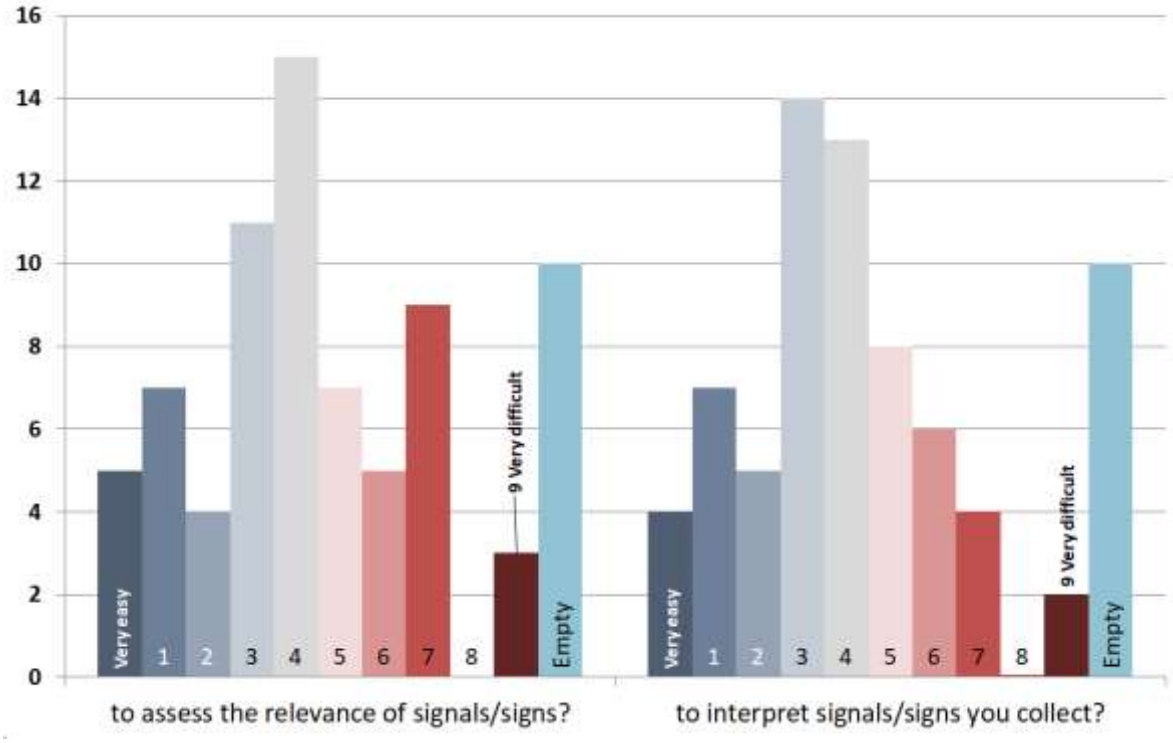
Answer Choices	Responses	
Daily: Less than 30 min per day	32,91%	26
Daily: Between 31 min and 60 min per day	16,46%	13
Daily: More than 60 min per day	10,13%	8
Weekly: Less than 30 min per week	6,33%	5
Weekly: Between 31 min and 60 min per week	6,33%	5
Weekly: Between 61 min and 120 min per week	2,53%	2
Weekly: More than 120 min per week	2,53%	2
Monthly: Less than 30 min per month	3,80%	3
Monthly: Between 31 min and 60 min per month	6,33%	5
Monthly: Between 61 min and 120 min per month	6,33%	5
Monthly: More than 120 min per month	1,27%	1
I don't know	5,06%	4
I don't want to respond	0,00%	0
N/A	0,00%	0
TOTAL (Answered)	**Answered**	**79**

Source: Question 13 of the survey

Individual appraisal of signals

In the sub-sample, 48 respondents (out of 76) directly collect signals themselves. These respondents are present in all categories of firms in the sample. Ten respondents left the question unanswered. Eighteen responded that they do not directly collect signals themselves in their organizations. Among the respondents who collect signals themselves, the questionnaire asked about the difficulty of assessing the relevance of signals and interpreting them. These elements are compared in Figure 10.

Figure 10
How difficult is it for you to assess the relevance of signals (left)... to interpret signals (right)?



Respondents appraised their responses with Lickert scales, from 0 ("very easy") to 9 ("very difficult"). The vertical axis displays the volume of respondents per bar in the bar chart.
Source: Question 28 of the questionnaire

In the diagrams, the blue bars display responses still on the "easy" side of the appraisal, while the red ones correspond to the "difficult side". The bars indicate that the same ten respondents (13% of the sub-sample, in turquoise bars) have not documented an answer to this question, while 66 responses were collected. The volume of respondents who have it more accessible to assess the relevance of signals, or to interpret them, are pictured with blue bars, ranging from very easy (increasing from 0, 1 to 2) in dark blue to medium assessments of easiness in light green (3 and 4). Medium difficulties (5 or 6) are represented with light red bars, increasing progressively towards nine and "very difficult" with dark red bars.

The diagrams compare the different aspects of the "sensing" phase (during which stimuli are sorted out against perceptive and conceptual filters), which involves investigating the signal relevance and then interpreting the signals.

There are a few differences on the left-hand side of the diagrams, where respondents easily assess or interpret signals. They represent the same proportion of the sub-sample (55.26% for the assessment and 56.58% for the interpretation). Proportions are also somewhat similar for the right-hand side of the diagram (respectively 31.58% for the evaluation of relevance, and 30.28% for the interpretation of signals). However, the repartition of responses for the levels of difficulties is not similar. Even if respondents provide subjective self-declarations that should be carefully considered, the action of "interpreting signals" seems slightly more manageable than the action of "assessing relevance". This interesting point is also present when interviewees explain that assessing the relevance of signals introduces significant problems in family businesses or smaller companies unless managers and employees are trained to focus on all details linked to security regulations or safety-related issues or when they are spontaneously trapped in paradigms.

Only eight respondents rely on an automatic system to collect signals (such as automated alerts generated by tracking systems in supply chain transportation systems or by algorithms scrutinizing the evolution of prices for supplies and macroeconomic variables). Eight respondents do not have any precise idea whether such a system exists in their companies, but 47 respondents provided a solid negative answer to this question.

Among those who are paying attention to signals, how do they appraise signals?

How often do they analyze signals?

Respondents have characterized the use of signals with specific responses. At the lowest extreme of subsample B (see Figure 11), three respondents mentioned that they never use collected data about signals, or that it does not apply to them. Two of them are operational managers in middle-sized firms owned by international groups, which tends to suggest that other people in their organizations probably compute these elements. The last one is the owner of a micro-company. It is more interesting to characterize the 15 respondents who do not know how often they use signals. Except for two CxOs and two CEOs in small companies, all are middle managers, operational managers (supervisors), or employees. Fifteen respondents explained that they do not know how often they use signals except two

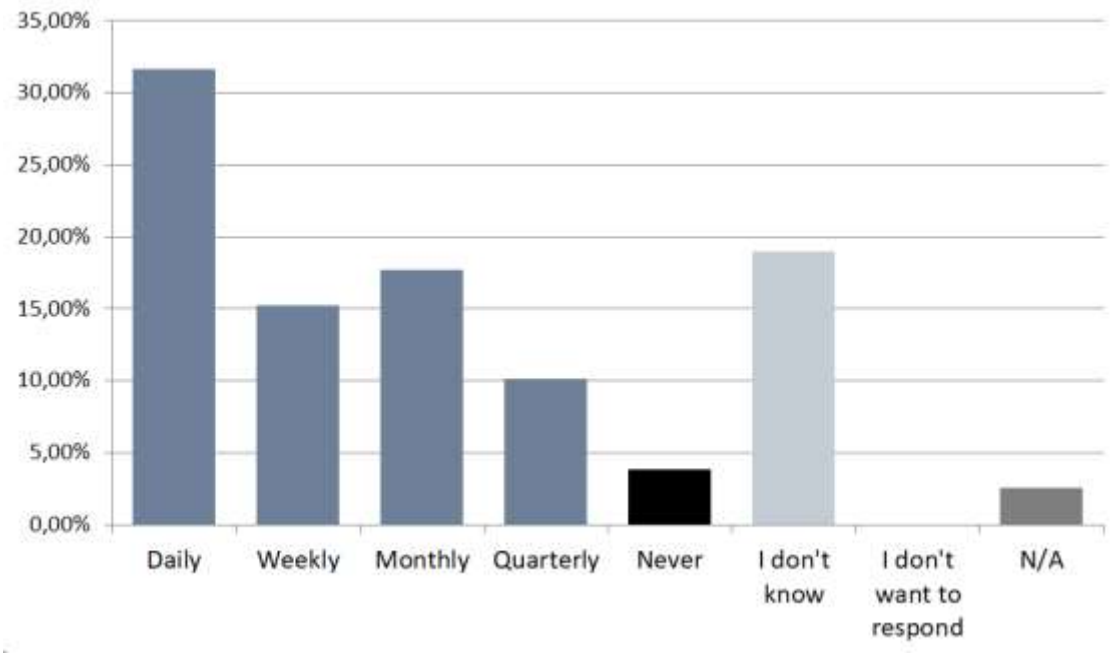
persons; they also documented that they spend less than 5% of their total workload on signal collection. The two exceptions claim to spend between 6% and 15% of their time on signal collection.

Among the ones who use signals, a significant number of respondents mentioned that they use signals on a daily or weekly basis. Daily users of EWS amount to 32.89% of the sub-sample, and weekly users 14.47%. Monthly or quarterly users represent 18.18% and 10.39% of the sub-sample. These elements justify assumptions about different categories of organizations and various categories of managers inside the firms. However, we can already introduce an educated guess about the evolution of behaviors in organizations once people have validated the importance of collecting signals because the data show an explicit use of data collected about signals.

The first elements to be analyzed regarding the use of EWS data relate to the categories of actors using these data in companies. We propose two visions of the subsample here.

The questionnaire shows that owners, managing directors, and middle managers focus on EWS daily, weekly, or, to a lesser extent, monthly. CxOs and administrators are not well represented in these questions because they do not represent an important volume of respondents in the sample.

Figure 11
How often do you use signals once collected? (Sub-sample B)



Source: Question 15 of the questionnaire

It is interesting to note that operational managers and frontline employees perform EWS-related tasks daily or monthly, probably depending on their responsibilities in companies. A significant number of middle managers, CxOs, middle managers, frontline managers, and their frontline employees do not have “any idea” of the focus devoted to EWS.

Frequency of signal use per category of respondent

Figure 12 provides a straightforward reading of the frequency of attentional effort for each category of respondent, while Figure 13 shows who is paying attention to EWS for each frequency of use.

Figure 12 shows that middle managers are the respondents from the sample who display the most important collection and use of early warning signals. However, when concatenating CxOs, managing directors, administrators and board members, and owners, the figures for “senior” managers show volumes of responses consistent with those evidenced by middle managers. The subsequent sections will aggregate all senior managers and compare them with the other categories.

This figure also displays information about employees that will no longer be commented on in the next sections. It shows that most of them devote either daily or weekly effort to the use of signals. They are then supposed to transport this information to the rest of the organization (see the last sections about the valorization of signals in organizations).

The same data are presented in Figure 13, focusing on periods used for the EWS collection and use. Each period of investigation shows the attentional effort performed for all categories of respondents.

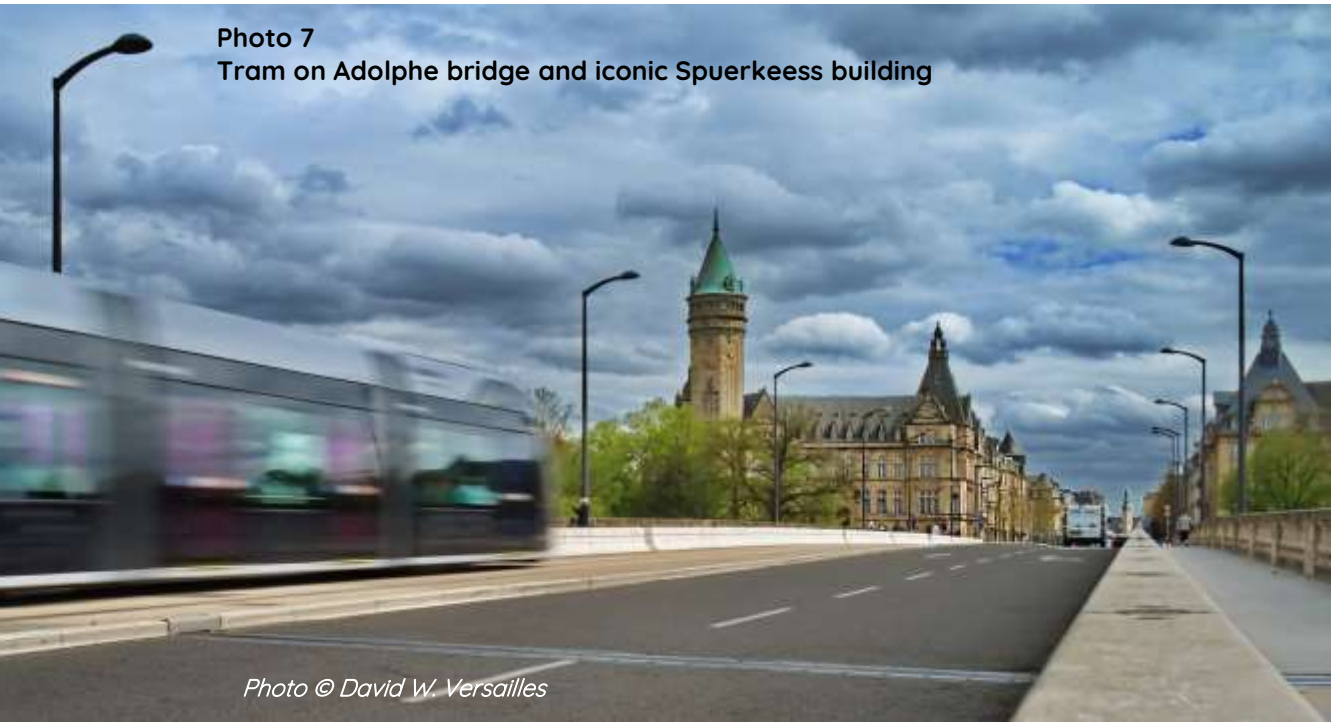


Photo 7
Tram on Adolphe bridge and iconic Spuerkeess building

Photo © David W. Versailles

Figure 12
Frequency of signal use per category of respondent (version 1)

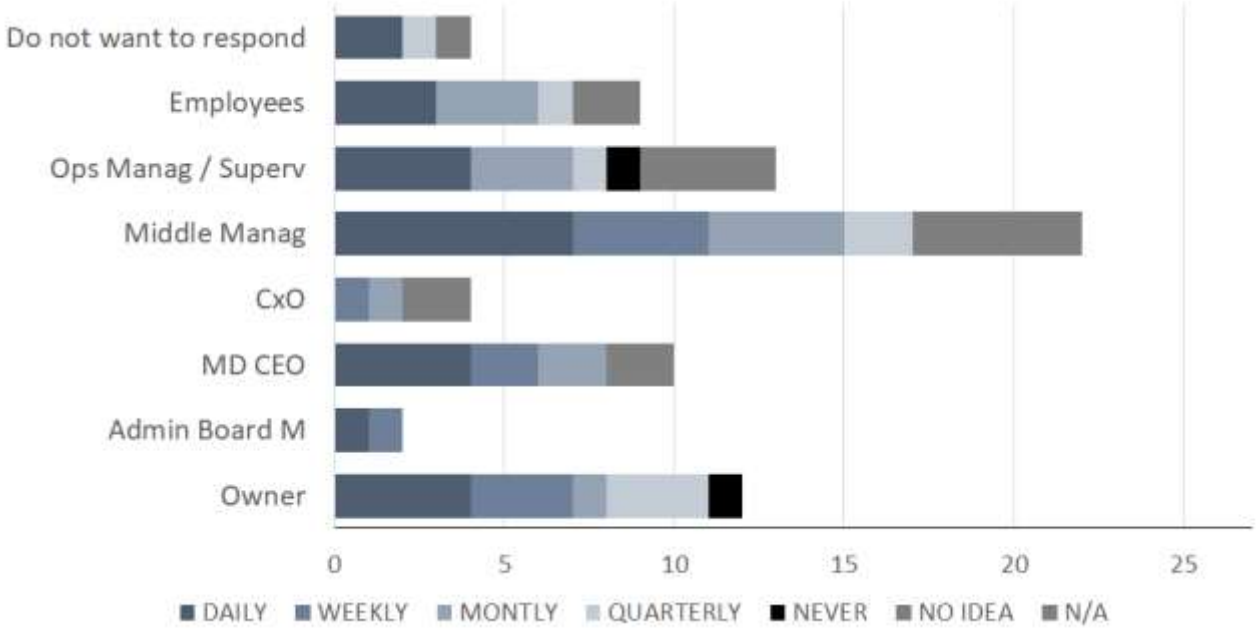
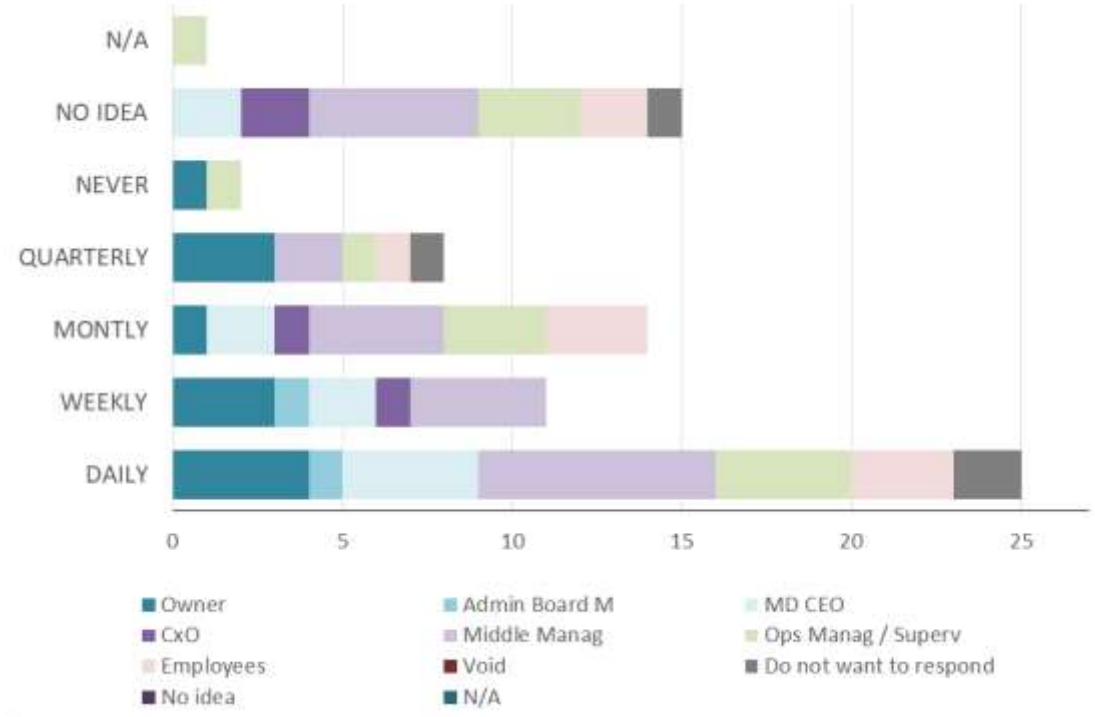


Figure 13
Frequency of signal use per category of respondent (version 2)



Source: Cross analysis of questions 18 (signal) and 9 (positions) of the questionnaire

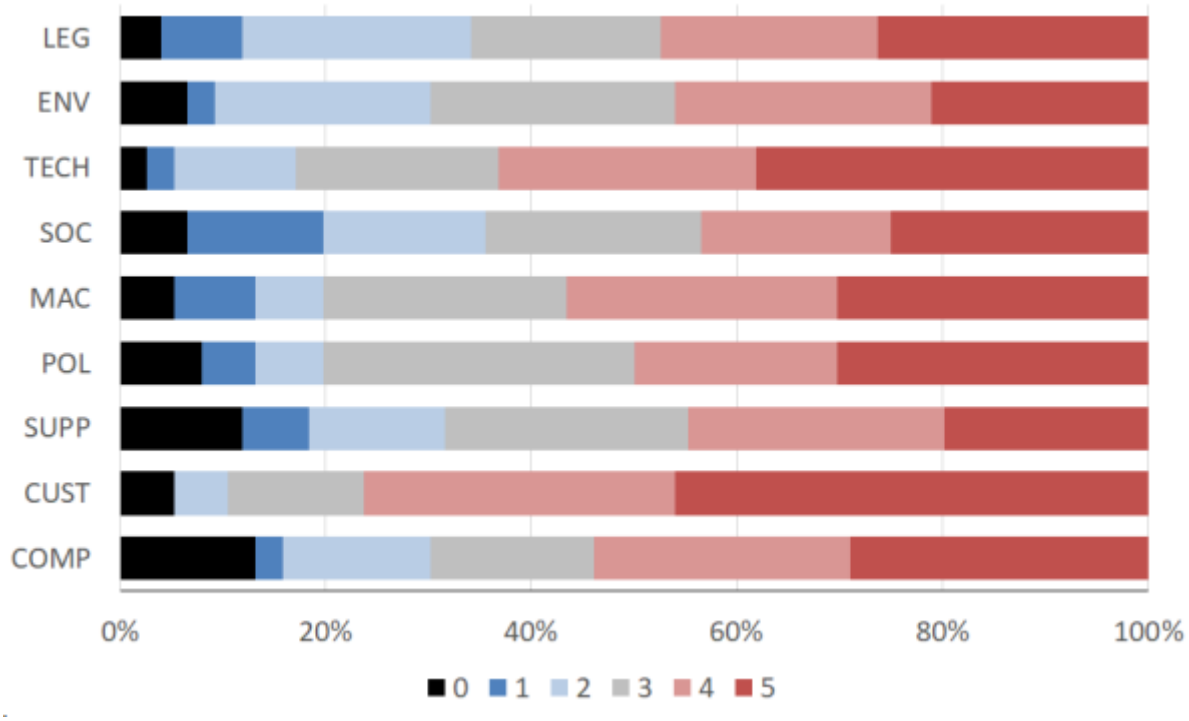
What is the focus of attention?

The questionnaire has investigated the different categories of EWS computed in firms. Questions were borrowed from the list of variables traditionally computed for the external analysis in corporate strategy: legal (LEG), environmental (ENV), technological (TECH), sociological and social (SOC), macroeconomic (MAC), and political or fiscal (POL) variables, or in relation with suppliers (SUPP), customers (CUST), and competition (COMP). The same codes are used in Figure 14 and 19.

Figure 14 displays data from subsample B, aggregated for all categories of respondents. It shows that EWS about customers, technology, and macroeconomic variables (and, to a lesser extent, competition, political, and legal issues) attract the most significant proportion of attention. This does not mean that the actors who collect and use EWS variables discard the other categories. Levels of importance were assessed between 0 (no importance) and 5 (very important).

There is no category of variable where the cumulation of 0, 1, and 2 scores is above the 40% threshold. Even if EWS about customers and technologies are the only categories displaying importance levels scored at 4 and 5 by more than 60% of respondents, all other categories exhibit similar levels for 40% to 60%. The focus on signals about customers even attracts scores at levels 4 and 5 for almost 80% of respondents.

Figure 14
Relative importance of signals used per category of topic (aggregated for all categories of respondents, sub-sample B)



Source: Question 17

Surprisingly enough, the cumulation of the 0 and 1 scores reaches its highest proportion of attraction for respondents (in sub-sample B) for the categories of sociological and societal issues and suppliers.

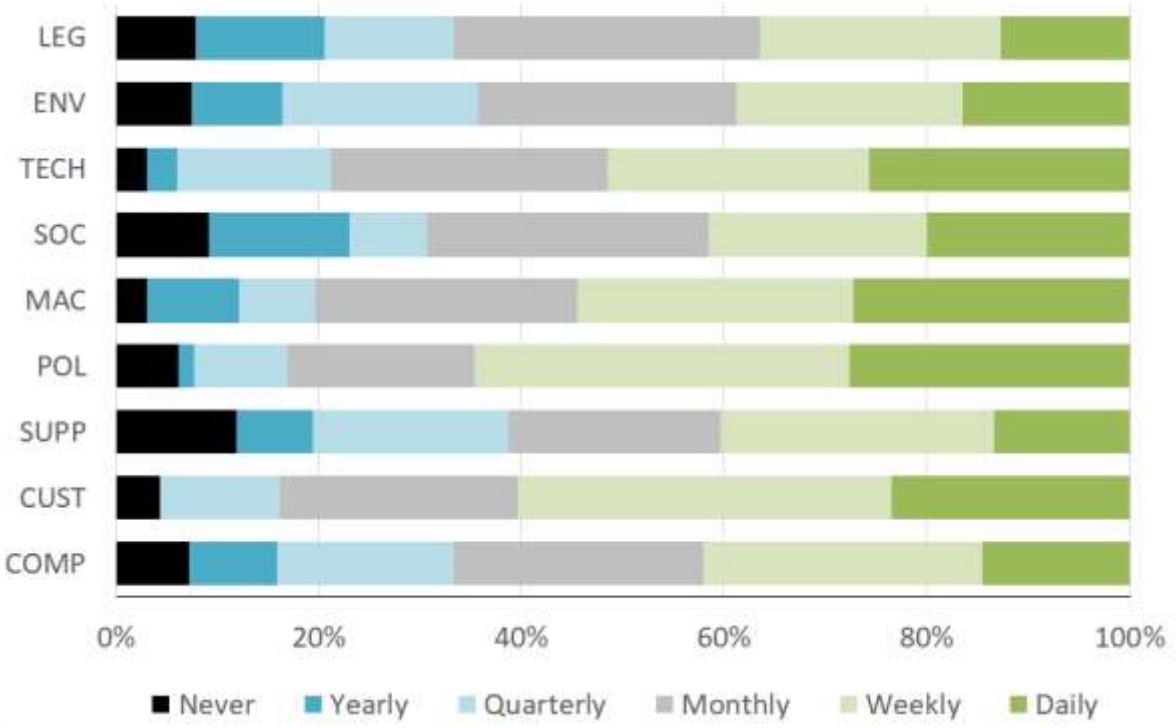
Frequency of use per signal category

The questionnaire investigated the nature of the effort to analyze signals, which correspond to activities in the "seizing" phases of the dynamic capabilities framework. Figure 15 displays the data collected for all respondents in subsample B. As for all other diagrams presented in this sub-section, the proportion of respondents who claim never to use signals is pictured in black in the bar charts. Calculations are based on the number of respondents who claim to use signals at each period (daily, weekly, monthly, quarterly, or yearly) for the different categories of data. Respondents cannot select two different use frequencies for the same item by construction.

Signal use and analysis are performed for sub-sample B (76 respondents). For each category, respondents can only provide one single response about their frequency of signal use.

Data show that the cumulation of daily and weekly signal uses always represents more than 30% of signal uses for all categories of topics (legal, environmental,

Figure 15
Signal attention per category of topic
(aggregated for all categories of respondents, sub-sample B)



Source: Cross analysis of questions 17 and 18

technological, sociological and social, macroeconomic, and political or fiscal variables, or in relation to suppliers, customers, and competition), and even more than 50% when dealing with customers and political issues.

When adding monthly uses to the daily and weekly ones, only environmental and legal issues are below the 60% threshold but still higher than 55%. Daily, weekly, and monthly routines account for 75% of the total activities for customer-related investigations, while political issues and macroeconomics account for around 70% of the total activities.

Between 4% and 11% of respondents do not know how to quantify the frequency of their use of signals, with the lowest figure for competition-related data and the highest level of doubt for legal issues.

Frequency of signal use per category of managers

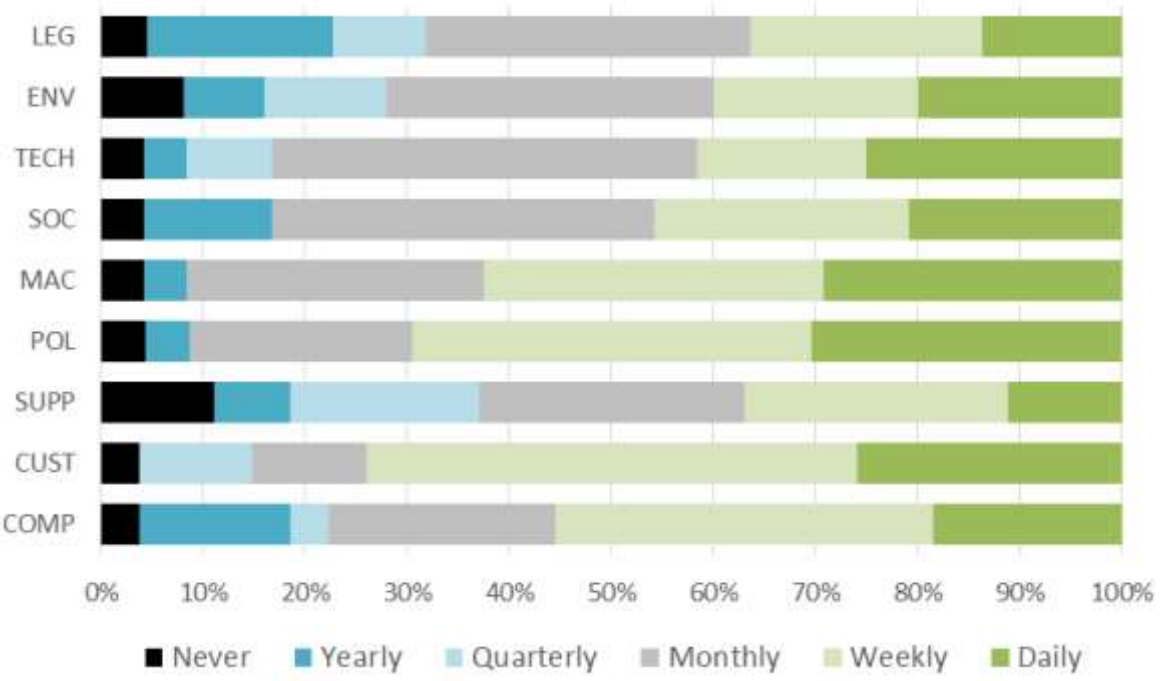
The cross-analysis of routines and seniority levels makes it possible to highlight interesting differences between senior and middle managers. The employee category has been disregarded in this analysis because these people seem to focus on EWS because of their job descriptions. Thus, in sub-sample B, diagrams and calculations now focus on 63 managers who have described their routines.

Table 3 presents raw data. In these figures, bar charts are presented after neutralizing non-qualified responses, which means that the 100% total only corresponds to respondents who qualified their answers as never, yearly, quarterly, monthly, weekly, or daily. In the text, percentages are conversely calculated against the total of all qualified and non-qualified responses, namely the “I don’t know”, “not applicable to me”, and blank fields. Figure 18 provides a diagram comparing these two categories of managers and provides visibility for non-qualified responses. All figures representing more than 25% of the sub-sample of middle or senior managers in the table are presented in bold font.

To build the sub-sample of senior managers, all CxOs, managing directors and CEOs, administrators and board members, and owners have been regrouped (28 respondents in total from sub-sample B).

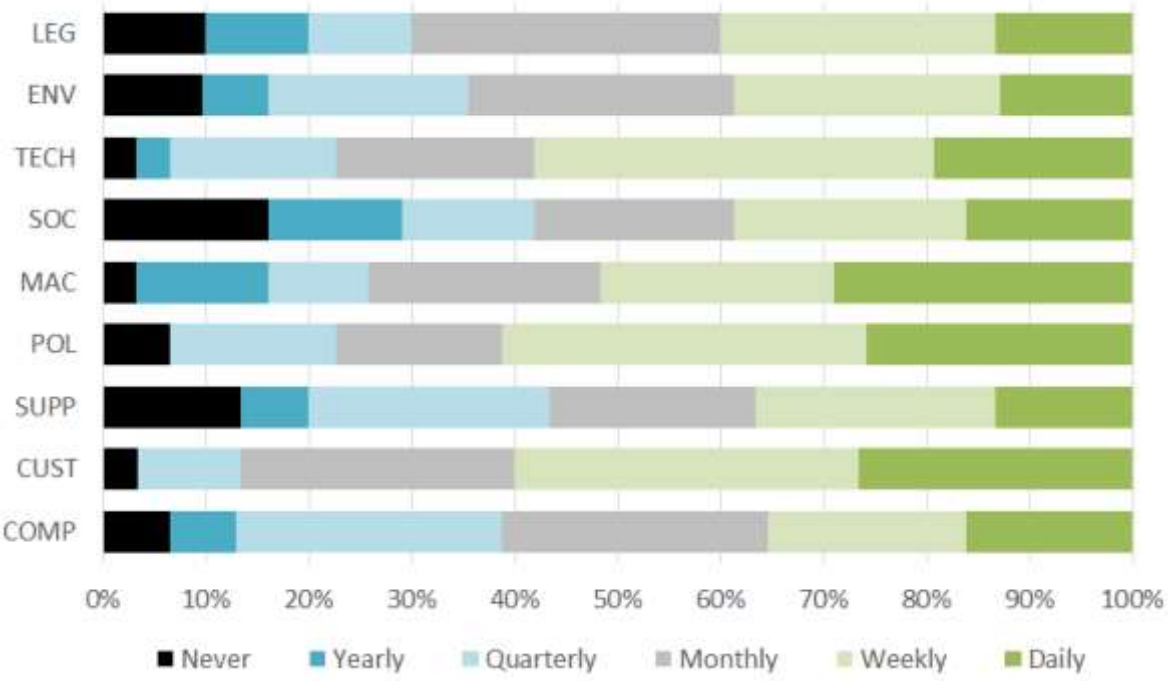
The questionnaire shows that all categories of signals are present in the senior managers’ attention (see Figure 16). The cumulation of total efforts always represents a minimum of 74.29% of EWS-related activities with the analysis of suppliers, and the maximum to macro-economic and technological variables (85.71%). Daily and weekly appraisals show very significant importance paid to politics-related variables (54.29%), customers (51.43%), technology (51.43%), and macroeconomic issues (45.71%). When cumulating daily and weekly with monthly appraisals, 68.57% of senior managers pay attention to politics and technology, and 65.71% to macroeconomics. However, the largest cumulation for the total attention paid is devoted to the investigation of signals about customers (74.29%), while the lowest cumulation is conversely devoted to suppliers (48.57%) and sociological issues (51.43%). One can introduce the assumption that the senior managers present in the sample consider these variables very stable. Another singularity should be mentioned. There is no direct annual consideration of customers and politics and,

Figure 16
EWS data analysis effort by senior managers



Source: Cross-analysis of questions 17 and 18, and of levels of seniority collected with question 9

Figure 17
EWS data analysis effort by middle managers



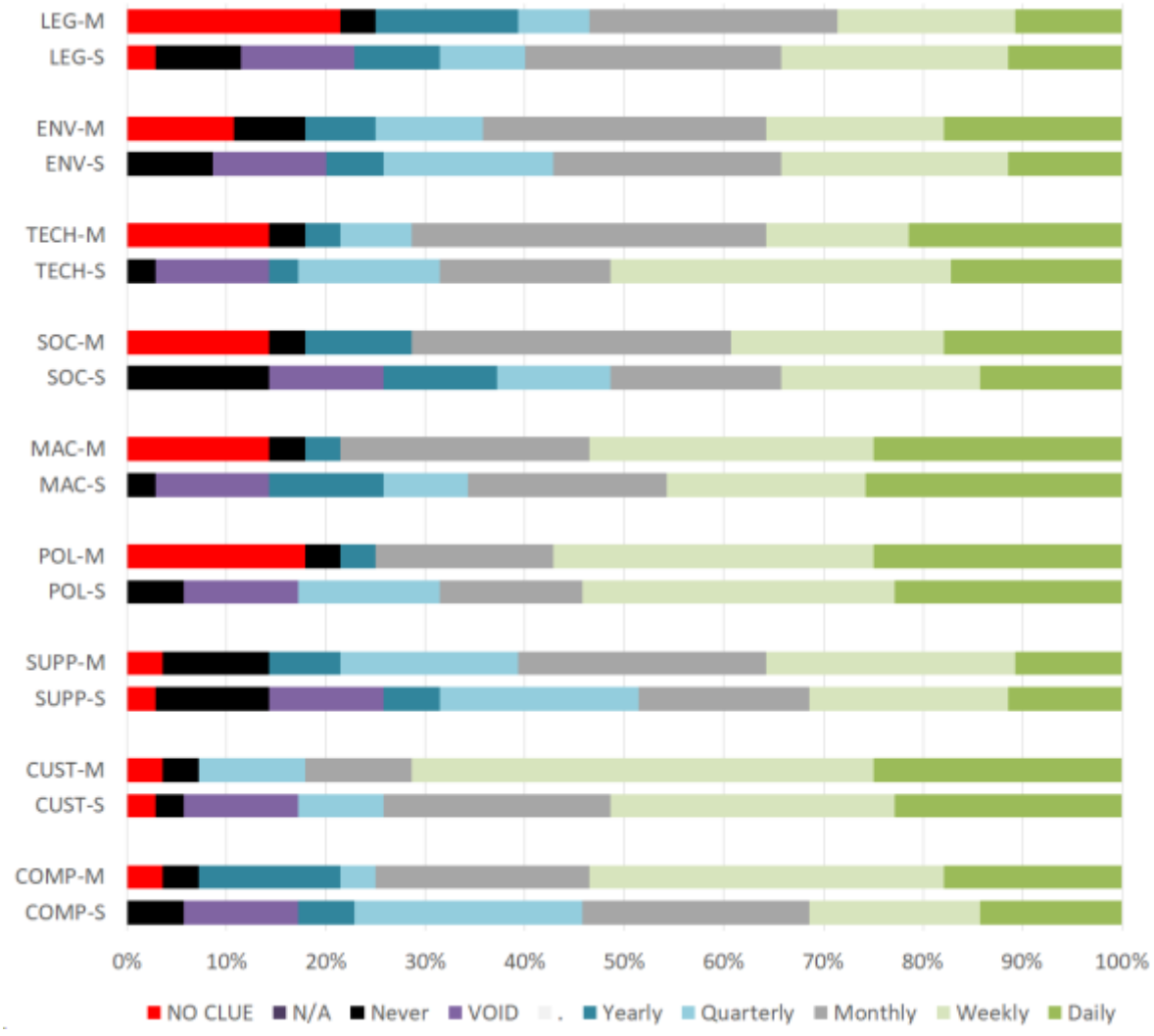
Source: Cross-analysis of questions 17 and 18, and of levels of seniority collected with question 9

to a lesser extent, of technology and environmental issues. At the same time, the total frequency of use is consistent with that identified for the other categories of variables. Last but not least, 14.29% of senior managers never use sociological variables, and 8.57% consider environmental and legal issues when developing their routines about external signals.

The sub-sample of middle managers considers responses provided by all middle managers, operational managers, and supervisors in sub-sample B (35 responses in total).

Middle managers responding to the questionnaire have disclosed that the less essential topics in their routines relate to legal (75%) and politics-related (78.57%) issues. Their most crucial attention is captured by variables about competition and customers (92.86% for these two variables).

Figure 18
Signal analysis effort by senior (-S) vs. middle managers (-M)



Source: Cross-analysis of questions 17 and 18, and of levels of seniority collected with question 9

Middle managers' most frequent daily routines focus on customers, politics, technology, and macroeconomics. These three categories account for 25% (or more) of daily attention focus.

The cumulation of daily and weekly routines shows that customer attention represents 71.43% of the total effort. To exceed the 75% threshold, weekly and monthly routines must be added to the daily ones for competition, politics, macroeconomics, and customer-related variables. Legal issues, suppliers, and environment-related signals "only" attract between 53.57% and 64.29% of the cumulated daily, weekly, and monthly routines.

Figure 17 shows that this is compensated for these three topics by quarterly and yearly routines (representing 17.86% of the total attentional effort for environment -related variables, 21.48% for legal issues, and 25% for suppliers).

Figure 18 and Table 3 make it easier to compare the attentional effort devoted to these categories by senior versus middle managers. In the figure, categories of senior managers are identified with the suffix "-S" while middle managers are identified with the suffix "-M". As mentioned, the table and the diagram display additional information about non-qualified responses, namely "I don't have any idea", "not applicable", and blank responses.

The data show that middle managers devote significantly more attention to competition in cumulated daily and weekly activities than senior managers (+22.14%), or cumulated daily, weekly, and monthly attention efforts (+20.71%). Middle managers devote more weekly attention to signals than senior managers for all categories except legal and technological issues. When computing the cumulation of daily, weekly, and monthly efforts, only legal issues demonstrate more attention paid by senior managers than middle managers. The converse situation prevails for the cumulation of monthly and quarterly attention that is significantly more important for senior managers in the domains of competition, customers, politics, and technology.

When considering the total attention attributed, four domains show a slightly lower attention level by middle managers: politics, macroeconomics, technology, and fiscal issues. The domains of competition, customers, suppliers, and sociology attract more attention from middle managers. Environmental problems are almost similarly addressed by senior and middle managers, with minimal attention paid by middle managers.

These data show some singularities for senior versus middle managers. Still, it seems easy to interpret them considering the links with SMEs and intermediate companies and the volume of independent entrepreneurs or family businesses in the sample. The separation of responsibilities between respondents typically focuses on short-term issues for middle managers and longer-term or more strategic issues for senior managers. The difference between senior and middle managers remains somewhat artificial when discussing the roles enacted by senior managers operating family businesses, smaller SMEs, or independent firms. In these cases, senior managers who still relate to a significant level of seniority must perform "menial" tasks that would be delegated to other (senior or middle) managers in larger organizations.

However, this point should be more carefully considered when appraising the volume of "non-qualified" responses. Middle managers show a pattern toward the "*I don't know*" answer in almost all domains, while slightly similar numbers of respondents among senior managers prefer to answer "*not applicable to me*." Nearly all categories of signals exhibit a small number of respondents who claim to "never" care about them.

Table 3
Signal analysis effort by senior vs. middle managers

Who?	What? / When?	COMP	CUST	SUPP	POL	MAC	SOC	TECH	ENV	LEG
Senior M	Never	1	1	3	1	1	1	1	2	1
	Daily	5	**7**	3	**7**	**7**	5	6	5	3
	Weekly	**10**	**13**	**7**	**9**	**8**	6	4	5	5
	Monthly	6	3	**7**	5	**7**	**9**	**10**	**8**	**7**
	Quarterly	1	3	5	0	0	0	2	3	2
	Yearly	4	0	2	1	1	3	1	2	4
	No clue	1	1	1	5	4	4	4	3	6
	Void	0	0	0	0	0	0	0	0	0
	N/A	0	0	0	0	0	0	0	0	0
	TOTAL	**28**	**28**	**28**	**28**	**28**	**28**	**28**	**28**	**28**
Middle M	Never	2	1	4	2	1	5	1	3	3
	Daily	5	**8**	4	**8**	**9**	5	6	4	4
	Weekly	6	**10**	7	**11**	7	7	**12**	**8**	**8**
	Monthly	**8**	**8**	6	5	7	6	6	**8**	**9**
	Quarterly	**8**	3	7	5	3	4	5	6	3
	Yearly	2	0	2	0	4	4	1	2	3
	No clue	0	1	1	0	0	0	0	0	1
	Void	4	4	4	4	4	4	4	4	4
	N/A	0	0	0	0	0	0	0	0	0
	TOTAL	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**	**35**

Source: Cross-analysis of questions 17 and 18, and of levels of seniority collected with question 9

The figures show that senior and middle managers share the same attention pattern (e.g., technology, environment, macroeconomics, suppliers, customers, competition), or senior managers disclose significantly higher levels of disinterest than middle managers (e.g., legal issues, sociology). Compared to the total of 35+28 responses collected with the survey, “non-qualified” and “never” responses still represent a cumulated 17% to 25% for senior managers and 15% to 25% for middle managers, except for the categories of competition and customers, which represent only 7.14% of the total responses.

Photo 8
Statues of business commuters eaten by the tram on Kirchberg

Photo © David W. Versailles

Which signal categories are SMEs vs. intermediate firms focusing on?

Responses to he questionnaire make it possible to analyze signals investigated by SMEs versus intermediate firms.

Figure 19 displays all results for the same categories of signals: legal, environmental, technological, sociological, macroeconomic, and political or fiscal variables or suppliers, customers, and competition. All these categories are documented in Figure 19 for SMEs (SME) and intermediate firms (INT). As earlier discussed concerning the comparison between senior versus middle managers, the diagram shows the level of attention disclosed by managers for each of these categories in SMEs vs. intermediate firms on a daily, weekly, monthly, quarterly, or annual basis.

Environment-related EWS are neglected in SMEs (see the importance of yearly and quarterly investigations) compared to intermediate firms. The same holds for sociological and societal issues and, to a lesser extent, macroeconomic variables. More attention is devoted to customer and competition-related EWS in SMEs than intermediate firms.

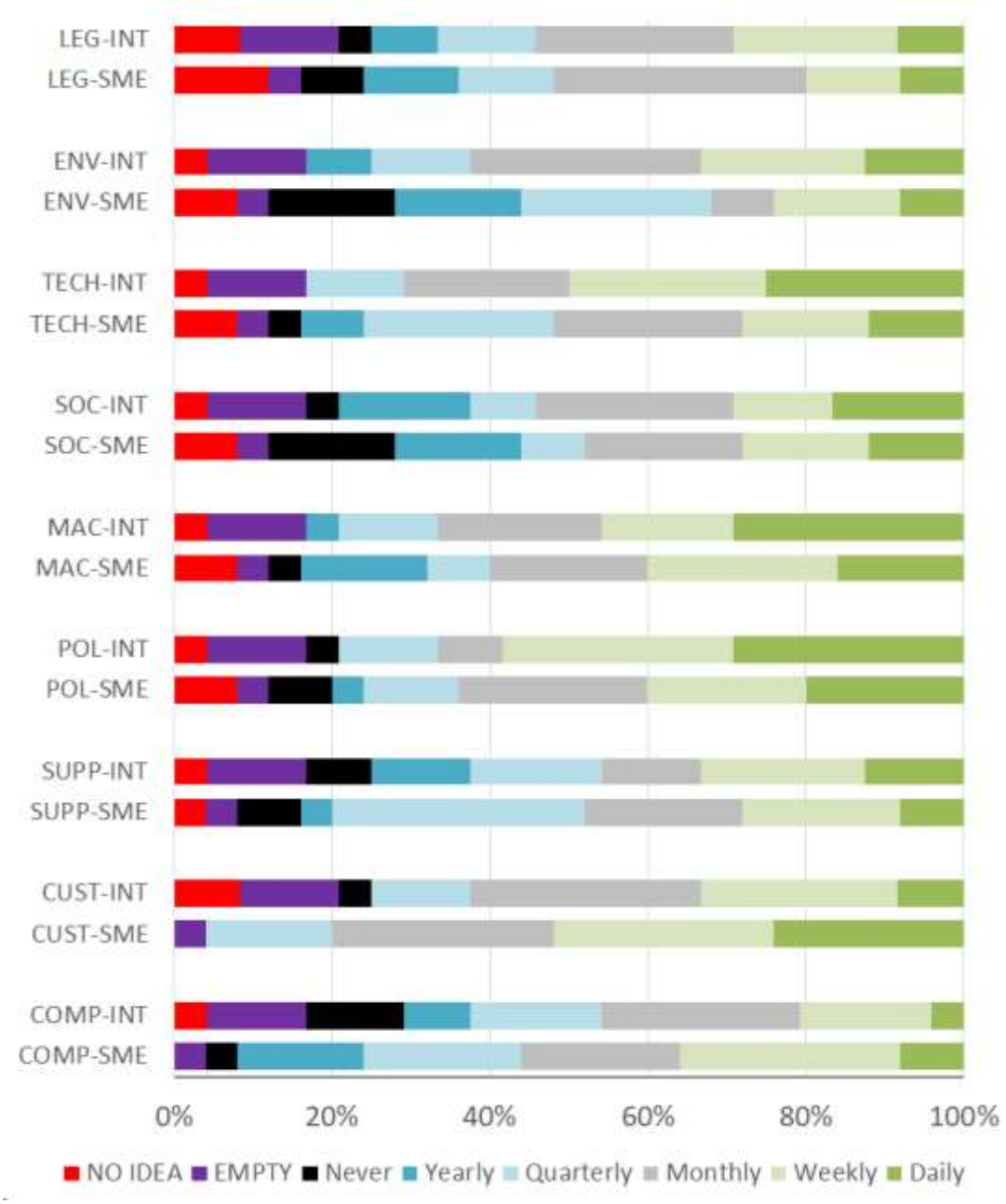
Intermediate firms have a strong focus on macroeconomic variables.

These elements should be compared to the interviews collected from large firms: interviewees explain that EWS collection and use either depends on other business units of their mother company or that they perform these tasks for the mother company.

Photo 9
Luxembourg's William Square, old City Hall and Kirchberg

Photo © David W. Versailles

Figure 19
Signals used in SMEs vs. Intermediate firms



Source: Cross-analysis of questions 17 and 18, and firms categories documented with questions 2, 3 and 4

How do signals travel inside companies?

The sample size makes it difficult to generalize about the different actions listed in the responses about how signals travel inside companies. All categories of respondents and firms use all modalities proposed in the list: adjust the agenda for a monthly team meeting, call for an ad-hoc CxO or head of BU meeting, call for a risk management committee (in large firms), call for an extraordinary team meeting, or even for a shareholder assembly. The most frequent response was organizing a "management and board meeting" to discuss signals.

Figure 20
Most frequent reporting communication after signal identification

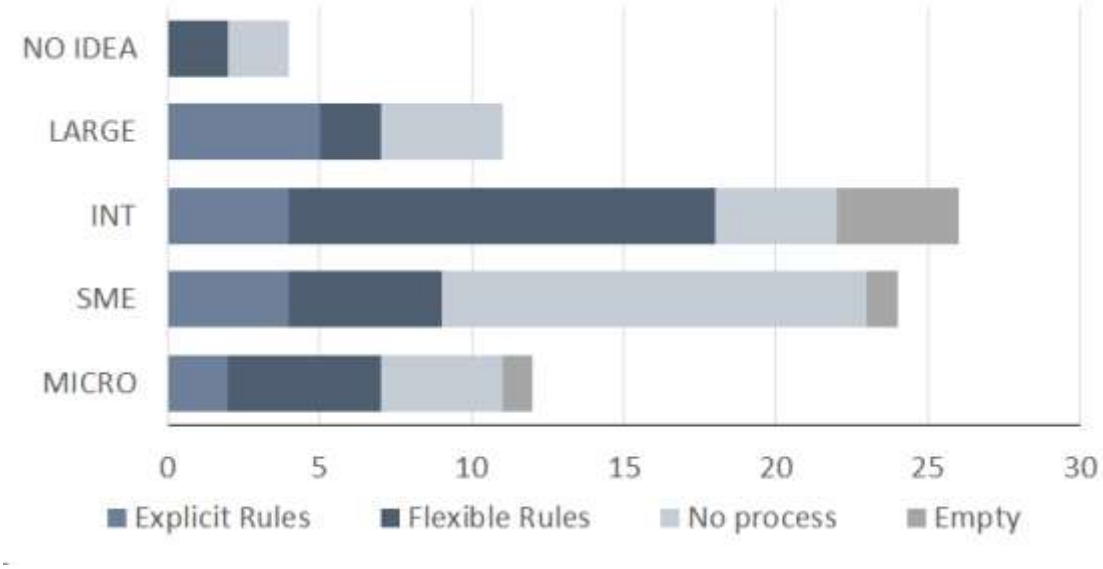
Source: Question 31

A focus on rules

Respondents from sub-sample B explain that a mix of flexible and explicit rules prevails when investigating signals. Figure 21 shows that the blend of rules differs according to company size, with a significant focus on informality in micro-companies, SMEs, and intermediate companies. The transition between no process for SMEs and flexible rules for intermediate firms still belongs to the same informal domain. Rules become more formal when the company size increases, which makes sense.

However, companies relying on strict explicit rules remain exceptions in the sample, even for large companies. The only explicit exception deals with subsidiaries or business units of international companies, for which interviews have identified that traveling information about signals throughout the group obeys very formal processes, either at the initiative of CxOs or specific offices in charge of assessing the signals.

Figure 21
Rules for the computation of signals in sub-sample B



Source: Cross-analysis of questions 3, 4, 5 an d 19

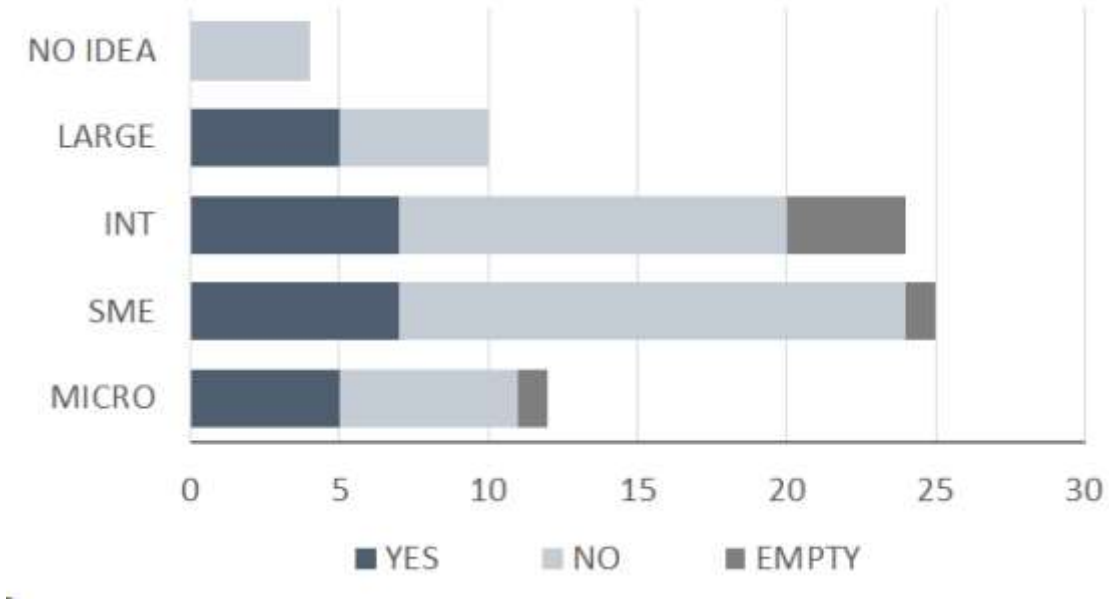
A focus on meetings

Only 19 respondents in the subsample have responded that the discussion of signals occurs during formal meetings. They have also sometimes provided multiple responses to these questions. The regular discussion of signals mainly occurs during regular team management meetings and board meetings, but also (by order of decreasing importance) during business reviews and managers meetings. Respondents mentioned supply chain reviews only twice. They identified client engagement meetings, technical meetings, and cash management meetings only once.

Twenty-one respondents (among the ones in the sub-sample) have mentioned the frequency of discussion about signals. Two have daily interactions (one in a

large company, the other in a SME). Most responses identify weekly discussions about signals; these respondents work in all categories of companies, from micro-companies to intermediate companies and large firms. Seven respondents identify monthly meetings, and three respondents mention quarterly meetings. There is no direct correlation between the frequency of discussions and the nature of the meetings identified by respondents. It is also impossible to infer rationales from the joint examination of the size of companies, the nature of meetings, and their frequency. The methodological problem behind this analytical limit results from the sample size: only 21 respondents provided precise details about the frequency of meetings, and only 19 among them documented the nature of these meetings.

Figure 22
Existence of scheduled discussions about signals



Source: Cross-analysis between questions 3, 4, 5 and 20

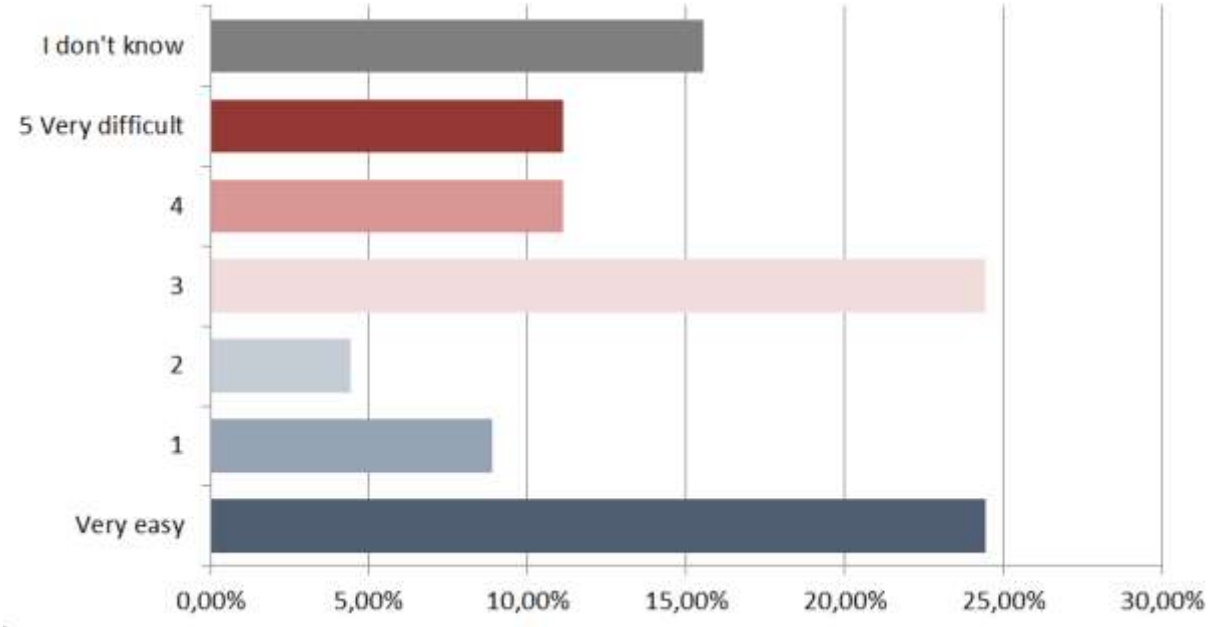
Respondents who documented the nature of regular meetings and their frequency in the questionnaire were never the ones who qualified the difficulty of putting the discussion of signals on the agenda of meetings. In subsample B (76 respondents), 31 people did not provide any answer to the question about the difficulty of discussing signals, out of which 19 qualified that signals were discussed during regular meetings. The questionnaire has collected 38 other responses, qualifying the difficulty of putting signals on the agenda of discussions. The absence of links with the previous questions does not allow us to infer assumptions about the nature of meetings where EWS elements will be eventually discussed.

Respondents have provided explanations for these assessments. They often mention that difficulties at putting these discussions on the agenda of a meeting are correlated with poor awareness in their companies about the importance of foresight and anticipation about forthcoming issues, with "poor" management, or with management understood as "top-down communication". Respondents show that oral communication between peers remains the prevailing communication modality to travel signals inside a company (Figure 20).

Free text responses in the questionnaire frequently use words already present during interviews: "*Too many topics to cover. Not enough resources and time*" or "*Most colleagues are too much focused on their day-to-day tasks. Opportunities are rather on away days*". It is a matter of resources and time available to compute signals. Free text questions in the questionnaire have also collected responses such as "*People don't want to discuss change*", thus showing frustration when topics are not explicitly listed in the "official" list of priorities and when business objectives are discarded.

Digging deeper into the data shows that these answers hide a repartition of prerogatives between the different layers of managers/employees versus senior managers or CxOs inside companies. Employees, who can be situated in the lower part of the hierarchy, always describe situations where they cannot spontaneously work on topics not explicitly listed in their "official" list of tasks, priorities, or business objectives. Other difficulties listed in this open question of the survey include company culture, trust issues in interactions with lower hierarchical levels, and trust issues correlated with gender topics. However, putting the discussion of signals on the agenda of a meeting remains difficult (Figure 23).

Figure 23
Difficulty of adding a discussion about signals on the agenda of a meeting



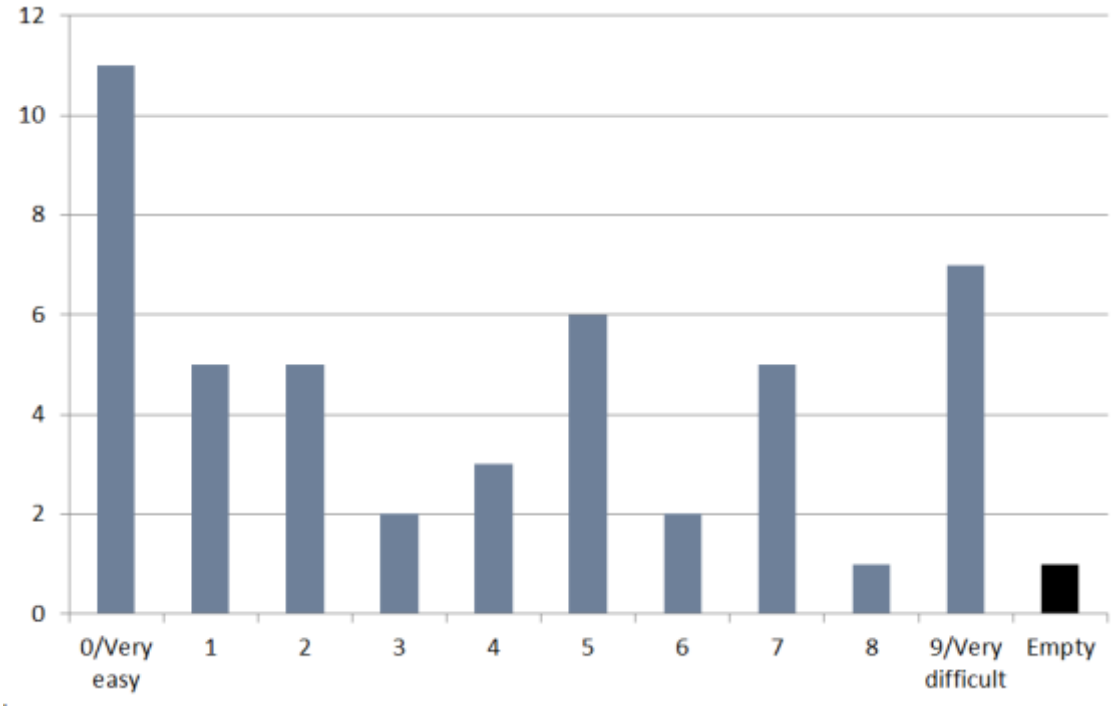
Source: Question 23

A focus on attracting managers' attention

When signals arrive in the company, interviews and responses to the questionnaire have indicated that getting managers' attention is a crucial topic for the management of signals and the early warning process. Interviewees made very explicit statements about this point: individual recognition of the relevance of signals and their qualification as early warning signals is nothing without the ability to gain management attention. The ability to develop appropriate decisions inside firms depends on managers who consider signals with the proper focus and level of precision, with the appropriate timing, and with the appropriate dissemination of information/knowledge derived from signals.

Whatever the firm's size, responses to the questionnaire explain that getting managers' attention is straightforward (Figure 24). Collected data show the difficulty in zooming out from daily management routines. Most respondents mention internal bureaucracy and mindset issues to explain this difficulty: focus on short-term problems and day-to-day activities. These aspects lead to the absence of perspective and difficulty when considering constraints with less tangible immediate consequences. At the same time, the duration of meetings is already too short to cover all day-to-day managerial problems.

Figure 24
Difficulty in attracting management attention after signal identification



Source: Question 32

Even though a high volume of responses in sub-sample B explains that it is very easy to get attention from the management, this response is biased because most open-ended answers commenting on this question also explicitly add: "*I am the management*", or "*I am the manager*". Both in small and large companies, comments such as "*Just talk directly to [managers, owners] and directly explain the seriousness of the topics*" or "*Everyone is involved*" are also present in the responses. This means that the answers documented on the left side of Figure 24 are not all reliable.

The survey reveals a contradiction (or a frustration) because of two questions proposed to cross-validate the answers. The first is about the respondents' motivations: "*Are you looking for a big picture?*". The second one is about the existence of eventual deep dives operated on specific topics when identified as relevant. Regarding the first question, 58 respondents out of 76 in the sub-sample claim they are looking for a big picture. Only nine respondents explained that they did not answer, and nine others did not provide any answer. To answer the second question, 47 respondents (out of 76) in the sub-sample explained that their organizations perform deep dives to document or investigate further the triggers brought to the surface by the signals.

The survey inquired about the departments in charge of these dives. Respondents could provide multiple answers, and the survey collected 105 responses from the 76 respondents. These elements were already presented around comments about Figure 8, and responses are very similar to the ones collected about the sources of signals. Twenty-seven respondents indicated that all departments of, or any department in, the company may be tasked with the big dives, and eight respondents also specified that an ad-hoc decision of the board is necessary before such activities.

Several respondents also indicated that signal-related activities are devoted explicitly to precise departments in their companies. In that case, the nature of the dive and the data to be further investigated leads to tasking a specialized company department: strategy, marketing, finance, risk management, supply chain management, and legal department. These elements make more sense when expecting improved qualifications for signals and the associated decision-making processes than they do for the initial grasping of signals present in ecosystems.

Reactions to the reception of signals

The small number of respondents who have qualified follow-up actions is very positive about the relevance of considering signals to handle risks and opportunities. 78% indicate that signals are "useful" or "very useful."

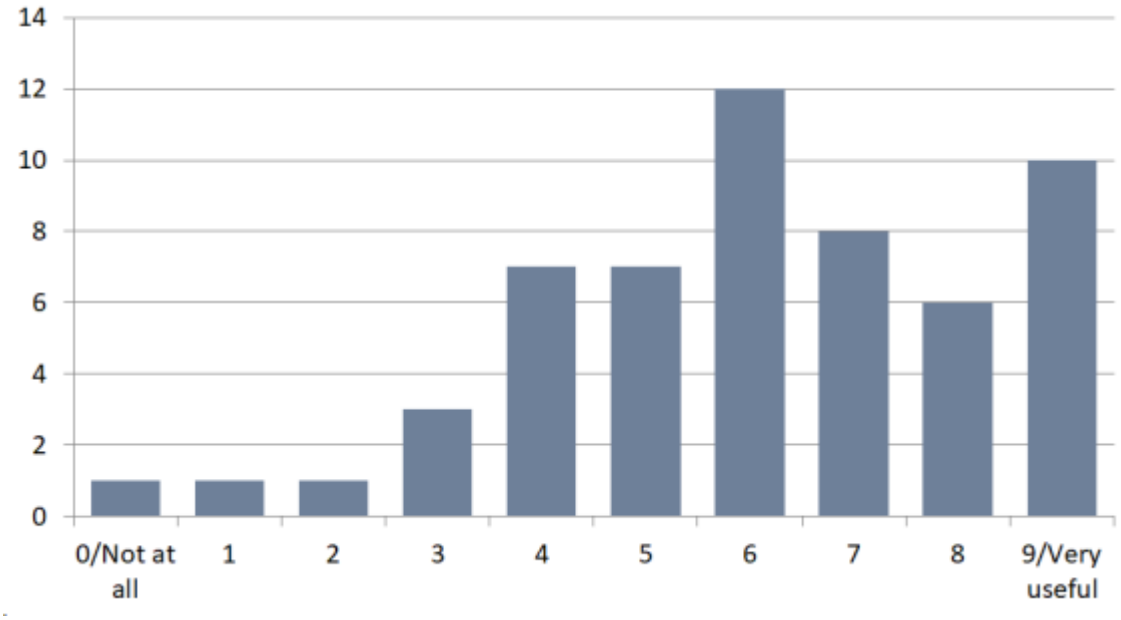
Signals received from colleagues and subordinates

In the initial subsample of 76 respondents who deal with EWS, we also identified a new subsample of 52 respondents who receive EWS from colleagues, subordinates, or superiors. These people have positions in all categories of firms identified in the sample. These respondents describe with open-ended answers what they do with such reporting. Two series of typical attitudes emerge from sub-sample C.

All people who describe themselves as employees say they will "*keep an eye out*" or "*think about these data*" in their subsequent activities.

All managers describe that they "*treat [EWS data] thoroughly*" and "*check their veracity*" before organizing further investigations about them. They "*take action*". The most frequent wrap-up written by an SME owner was "*interpret, follow up, analyze, communicate*." Lots of respondents who do not have their positions in

Figure 25
Does attention paid to signals received from subordinates/colleagues pay off?



Source: Question 44

micro-companies describe the redaction of memos, the organization of 1-to-1 meetings, and eventually group analysis to "*prepare solutions*". One of the respondents even justifies his action with a long comment: "*Knowing the proper road signs and traffic light signals are essential in keeping you safe while driving and making sure you stick to the proper rules and regulations.*" Some comments quickly indicate that action is taken, or that it is necessary to listen to such reports and that "*shooting the messenger is not an option*". However, a strong correlation emerges between the respondent's seniority and the existence of articulated reactions. Senior managers usually indicate at least two steps after the reporting: first, a consistency check or a verification with further investigations and, if proven valid, either the redaction of a memo to keep track of the signal or the immediate introduction of a "*corrective plan*". In any case, all respondents warned about signals by subordinates explain in their responses that they "*take action*".

This homogeneity among responses leads to specific concerns because it confirms a selection bias in the sample: respondents taking the survey until this section are most probably already convinced about the relevance of the signal collection. The survey does not reveal attitudes and reactions by more suspicious people or people who do not care about signals. Therefore, it is not surprising that most of these people document that the attention paid to signals helps handle risks (compare Figure 25).

Photo 10
The Big Banker statue
on Kirchberg's J.F. Kennedy avenue

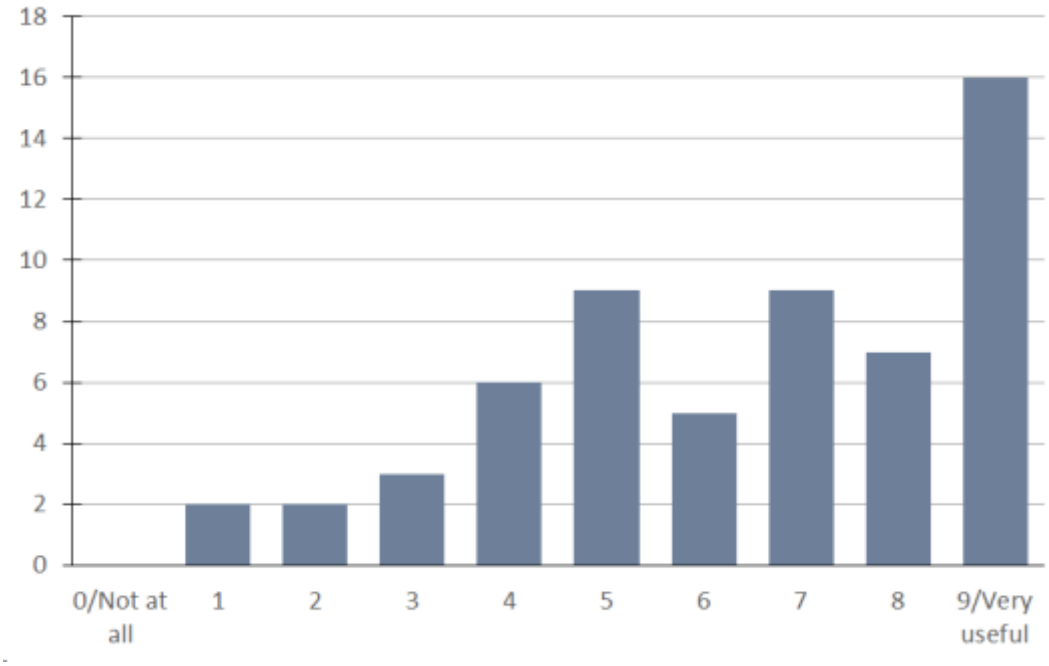
Signals received from “third parties”

The questionnaire deliberately left the definition of “third parties” quite vague to accommodate a variety of interpretations and asked respondents to characterize their sources later. In the initial sub-sample of 76 respondents who deal with signals, 43 respondents receive signals from “third parties” or “external parties”. Ten respondents did not respond to this question and went directly to the last phase of the questionnaire, which dealt with personal details. However, 22 respondents provided a negative answer to this answer.

Some of the positive answers are provided by respondents who have already answered one of the questions about the reception of EWS data from colleagues and subordinates. Surprisingly, 66 respondents in total provided answers in this section, meaning that 23 respondents did not claim to receive data from “third parties” even though they documented the other questions.

These 66 respondents qualified the relevance of the attention paid to these signals to help handle risks and opportunities (compare Figure 26). The diagram shows that most respondents associate the computation of signals with a positive impact on their businesses. The chart clearly shows this relevance with scores higher than the average. The sample potentially faces the same positive selection bias as the one already observed in the previous section about signals received from colleagues and subordinates.

Figure 26
Does attention paid to signals received from third parties pay off?



Source: Question 47

The list of "third parties" providing signals deserves more attention. As "third party" sources, respondents listed items not much different from the ones listed earlier by respondents who collect signals themselves. The questionnaire has accepted open-ended responses to qualify these sources better. Some respondents only mention "network". Respondents mainly list their responses without introducing any priority. However, several of them introduce a ranking such as: "*clients > suppliers > competitors*" or "*suppliers > media*". Zooming out from all responses received in the survey, three main categories of "third parties" emerge: specialized media, clients and end-users (together), national institutions or regulatory bodies; and all categories of suppliers. It remains impossible to justify a precise ranking considering the explorative nature of the survey.

- Peers and other market players
- Consultants, think tanks, analysts, industry reviews, industry news, opinion leaders,
- Professional organizations
- CPA, banks,
- Specialized media (Bloomberg, Factiva, Refinitiv, etc.), newsletters in general
- Clients and end-users, even when introducing complaints
- International (EU) and national institutions, regulators
- Suppliers
- Collaborations and business partners
- Family and friends, acquaintances,
- HR partners and data about the job market
- Colleagues.

Who is making decisions about signals? A focus on follow-up actions

At the end of the questionnaire, due to all the additions introduced with conditional questions, the responses about follow-up actions and decision-making processes are more challenging to analyze because the number of respondents to the questionnaire sometimes demonstrates very low statistical significance. These elements bring value to the exploration of new leads in the analysis of processes in place to manage early warning signals. However, the possibility of generalizing from our sample of interviewees and respondents is weak. It is, therefore, essential to interpret the data collected from the questionnaire in the light of interviews.

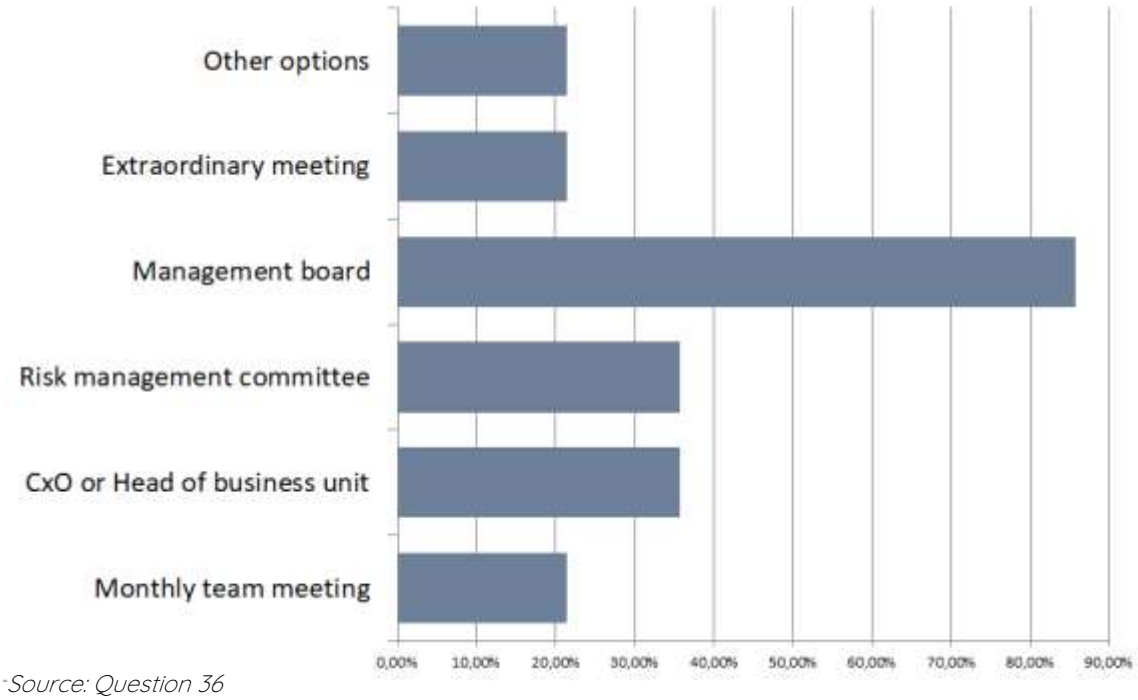
In sub-sample B, 45.83% of respondents who collected and qualified signals as relevant "early warning signals" have declared that they are involved in follow-up actions devoted either to "deep dives" or to decision-making processes following the qualification of signals (question 34). 37.50% also disclosed that they are "sometimes" involved in such actions. These elements are consistent with the data collected from interviews, even though these elements could be better understood

if data cross-analyzing the results with the respondents' status and the companies' size were available. Considering the large proportion of respondents coming from SMEs and intermediate companies, it is most likely that the involvement in follow-up actions will not be similar in all categories of firms and that the size of the staff and available individual competencies matter.

With respect to satisfaction levels regarding follow-up actions and usages of signals once transferred to their organizations, most respondents provide "yes" answers (question 37), and explain later that actions were taken, consensus emerged, and risk mitigation actions were easy to notice in companies. All respondents providing a "no" answer (question 34) remained silent and did not comment. When inquiring about the involvement of middle managers, operational managers, and employees in follow-up actions after reporting a signal, the most frequent response was "sometimes". The most frequent response was only a solid "yes" for all respondents in senior positions.

In Figure 27, percentages indicate how many respondents qualify each modality in their response, with the possibility of mentioning several different meetings either for the analysis of the same signals or for the qualification of signals. Standard management board meetings attract the main volume of responses. Regular monthly management meetings or risk management meetings are often used for the regular appraisal of signals. For "urgent" signals, some firms call for extraordinary meetings. One respondent even refers to the shareholder board for decisions about EWS; another respondent refers to the Chief Innovation officer and another one to the Executive committee (see "others" in the diagram).

Figure 27
Formal bodies making decisions about signals



Source: Question 36

It is very interesting to note that more than 35% of respondents indicate that CxOs or heads of business units do not need any formal meeting to decide about signals and subsequent adaptation actions. Their status as CxOs or heads of business units indicates that their positions are rather associated with large firms and they have the autonomy of decision possibly characterizing owners, entrepreneurs, or managing directors in smaller firms. However, their qualification as CxOs or heads of business units suggests that their decisions cannot cover all aspects of business model reconfiguration.

Sunset above Kirchberg's cranes and skyscrapers

Photo © David W. Versailles

4. Lessons learnt & returns on experience

Interviewees and respondents confirmed that companies use “early warning signals” to “navigate the unknown” and adapt to external contingencies. Even if interviewees and respondents do not introduce any difference between the management of risks and uncertainty, they explain that the attention paid to early warning signals represents a means to secure or strengthen their competitive advantage. This research about early warning signals confirms several points already present in the academic literature about corporate strategy. It also introduces new insights about the “organizational drivetrain” (cf. Di Stefano, Peteraf, and Verona, 2014, see pages 22-23). This investigation improves understanding of the ways of working about the “sensing” and “seizing” phases leading to business model adaptation and proactive management of potential risks and disasters.

The conclusions of this White book should be carefully considered because the sample of interviewees and respondents to the questionnaire shows a bias towards positive attitudes about the collection and computation of early warning signals. Managers and employees not considering the topic as important dropped out of the questionnaire or did not accept to meet for interviews. Several managers who have a position in multinationals also explained that they rely on computations proposed by other entities of the group, most notably when they work in the financial sector. Others heading global business units also explain that they oversee such tasks for the whole company in a specific area, for instance, supply chain management. This research therefore only discusses ways of working when the relevance of early warning signals has been acknowledged in an organization. It does not tell anything about how to convince managers to use early warning signals when they are not willing to learn from them. For all firms, big or small, the first prerequisite remains the willingness to learn.

Interviewees who are directly aware of the importance of signals are eager to learn about additional signals. They look for signals that make the qualification of stimuli into relevant information more manageable and accurate. For all firms, big or small, managers who have already experienced a failure due to the lack of awareness of early warning signals no longer look for confirmatory data. They now search for outliers and “black swans” to improve their strategic decisions.

"The pandemic, of course, had a massive impact on us, and I have to admit that we completely, completely, underestimated what was going to happen. To be completely honest, we just reacted because we had to... […] Every day was a new adventure."

CEO of a startup based in Luxembourg

Interviews also show that firms already aware of the importance of signals because they deal with stringent safety and security issues are more likely to have

the appropriate processes for signal diffusion throughout their organizations and make the best use of signals for early warning. This means that an investigation of boundary conditions leading to improved awareness about the need for signals and an appetite for signals should be installed in all categories of firms to understand better how to foster the collection and computation of signals. The sample shows that the "organizational drivetrain" is more effective after organizations have faced hazardous events such as the 2021 flooding in Luxembourg or the COVID-19 pandemic. Most interviewees explain that the lessons learned from previous disasters increased the level of preparedness and the ability to react to other crises.

Photo 12
Luxembourg's station district and Adolphe bridge

Photo © David W. Versailles

Respondents from all categories of companies, and from all categories of managers (owners, managing directors, board members, CxOs, administrators; middle managers; and operational managers and supervisors) all confirmed that they scrutinize EWS. However, they do neither devote the same attention to EWS (i.e. total signal collection effort and frequency of effort) nor focus on the same categories of signals/data. Middle managers demonstrate the most frequent signal use (as compared to all categories of managers responding to the survey) even though all categories of managers acknowledge spending some time every day about EWS signal collection and appraisal.

Responses to the questionnaire and interviews explain that a broad range of ways of working exist in companies to manage signals, and their qualification into "early warning signals". At one extreme, some managers and companies allegedly do nothing. Some managers responding to the questionnaire do not claim any reference to early warning signals at all, most notably when their companies relate to larger organizations (e.g., international groups) where other offices manage such signals. Some companies either do not see the need to collect signals and adapt, or do not know what to do with available signals.

At the other end of the spectrum, managers and companies are firmly committed to investigating "noises" and detecting early warning signals. Interviews collected during the project show balanced and nuanced attitudes that are not automatically present in the responses to the questionnaire. They should be carefully considered because they confirm a bias in the responses in favor of positive commitments towards the sensing and seizing of signals .

Interviews have indicated that the propensity to use signals and recognize their value as "early warning signals" increases when companies belong to an international group. This does not mean that subsidiaries or offices will be tasked with the "seizing" of signals, but that groups have installed processes to collect "signals" from all their sub-parts and disseminate the subsequent warnings after seizing the relevance or "early warnings". In the case of SMEs and intermediate companies, the reference to "early warning signals" is complex to generalize as interviewees and respondents to the questionnaire did not provide coherent results.

"Since we are part of a financial group,
we have all these compliance rules:
"Know your suppliers",
"Know your customers",
"Know your employee".
All these processes add up to
the external scanning process."

CxO in a Luxembourg-based subsidiary.

Pragmaticism prevails for the sources of EWS and the department in charge of collecting/appraising EWS. All sources of signals/data are accepted (see page 42). Managers acknowledge that the attention paid to signals received from subordinates and colleagues pays off. All claim to "*take action*": they eventually commission "deep dives" or directly perform further investigations themselves. They also explain that "*shooting the messenger is not an option*." The same conclusion holds for signals received from "third parties", a term with a deliberately loose definition. Open-ended responses were organized under three categories of stakeholders: specialized media, clients and end-users; national institutions or regulatory bodies; and all categories of suppliers.

This is nicely illustrated by two different interviews performed in companies where managers are heavily committed to the collection of signals and their interpretation. In the first one, an intermediate company with a strong culture focusing on

safety issues, the fact that all staff members and managers are trained to detect quality issues impacting safety made it easy and quick to react and invent appropriate solutions when the flooding occurred in Luxembourg. In the other one, the global business unit where the scrutinization of supply chain data is among the main tasks operated for the whole multinational that they belong to, the cumulation of small independent details and their joint appraisal made it possible to have a smooth transition into the lockdown when the pandemic exploded in the Grande Region.

"Signals are there.
You must listen to them,
and you must communicate about them."

CxO in an international group actively working on signals.

Interviewees explicitly state the importance of active listening to signals and proactive attitudes toward signal collection and interpretation ("sensing" in the literature about dynamic capabilities and business models) before jumping into ways of working and activities leading to decisions about the relevance of signals and corrective measures ("seizing").

More than 55% of respondents explain that they easily access or interpret signals, while around 30% find it difficult. Even if self-declarations should be carefully considered, it seems that "interpreting signals" is slightly more difficult than "assessing the relevance of signals". Interviewees also explained that signal collection is less difficult than the proper use of signals for business model adaptation or strategic reconfiguration. Interviews and open-text responses in the questionnaire also clearly indicate that decision-makers consider the use of early warning signals as a very traditional part of any entrepreneurial journey (either at an early stage in a startup or later when a firm is already established as SME, intermediate company or "large" company).

"This is about being an entrepreneur.
I try to anticipate problems before they come.
[...] I try to listen to what happens around me,
and I try to adapt. [...] I must grasp what is important for the business and what isn't.
I need to filter somewhat what's happening around me and focus on the things that I think are going to matter. That's something every entrepreneur has to do every day."

CEO in an SME based in Luxembourg.

This investigation can easily expand thanks to connections with research about corporate foresight and the theory-based view of entrepreneurship. The nature of business model adaptation and the links with entrepreneurial ventures were not directly present in the questionnaire but were spontaneously and systematically commented on by the interviewees.

This research has compared signals linked to the external and internal analyses of the firm (politics and fiscal policies, economics, sociology, technology, environment, legal issues, suppliers, customers, and competition). Even though direct links exist between data about clients and the marketing department, or between macro-economic signals and the finance department, the main important links are located in departments in charge of risk management (incl. safety) and corporate strategy.

Photo 13
Luxembourg's iconic Spuerkeess building on Metz square and Liberty avenue

Photo © David W. Versailles

"I'm following one or two categories of indicators. For me, the most interesting ones show long-term tendencies. The first category indicates the evolution of costs. The other one is more something like societal indicators. It provides insights about how to make sense of the other figures."

CEO in a large company.

The cross-analysis of work routines, seniority levels and categories of signals shows interesting differences between senior and middle managers. The tables and diagrams available in the previous section highlight differences between middle and senior managers and between SMEs and intermediate companies.

All categories of signals are present in the senior managers' attention, with a focus on suppliers, technology and macro-economic variables when considering global annual efforts, while the cumulation of daily and weekly routines rather focus on clients and politics. Middle managers conversely focus on competition, customers, suppliers and sociological drivers, even if the other categories of signals are never totally absent from their scanning. Senior and middle managers similarly address signals linked to environmental issues with minimal attention. For an equivalent cumulation of daily, weekly, and monthly technology-related input between senior and middle managers, differences emerged in the fact that senior managers prevailingly focus on this topic on a weekly basis, whereas middle managers only work about this topic monthly.

Some differences also exist between SMEs, intermediate firms, and large companies. The questionnaire shows a strong propensity of SME managers to intensely investigate customer-related signals and, to a lesser extent, competition, while managers positioned in intermediate firms also focus very much on environment-related variables. In the questionnaire, there is not much difference between these companies regarding the "seizing" of signals about suppliers, macroeconomics, legal issues, and public policies. Interviews conversely showed a solid propensity to focus on technology, innovation, and public policies. Environment-related issues, sociological and societal issues, and, to a lesser extent, macroeconomic variables are more neglected in SMEs than in intermediate firms. More attention is devoted to customers and competition in SMEs than in intermediate firms. In large firms, the focus on EWS categories depends on the nature of the business unit versus the headquarters.

As interviewees are almost all senior managers (i.e., owners, board members, administrators, managing directors, or CxOs), data collected during the interviews are consistent with those collected in the questionnaire with senior managers: they have a distinct focus on all issues that impact companies in the longer terms than middle managers who instead focus on short term issues.

These elements offer interesting leads to understanding how to conceive and deliver training for managers in different positions or seniority levels, and various categories of companies.

As learnt from the interviewees, the level of complexity for the "seizing" differs for each category of variable: building macroeconomic scenarios is more complex and requires more specialized education than competition or customers. The conclusions collected about "deep dives" reflect these technical difficulties: in large companies, specialized departments (finance, legal issues, etc.) are usually tasked with these additional investigations, but this cannot apply to smaller companies (SMEs, startups) where these technical debates cannot rely on internal staff.

The survey and the interviews show that signals travel quite well throughout organizations, with a mix of flexible, explicit, formal, and informal routines that unsurprisingly reflect the size of the organizations or the nature of their management (consider, for instance, the originality of family firms or SMEs with strong owner's presence). Oral communication between peers remains the prevailing communication modality to travel signals inside a company. Explicit rules prevail in large firms. Flexible rules are the norm in intermediate companies. Informality and absence of predefined processes prevail in SMEs. Survey respondents and interviewees explain that no formal discussion is scheduled during management meetings in SMEs and intermediate firms. Still, all of them also document that it is always easy to put the discussion of signals on the agenda. Difficulties arise when facing poor awareness about the importance of foresight, when confronting a culture of top-down management, when day-to-day tasks make it impossible to zoom out, or when too many topics are on the agenda of meetings.

**"We have people who are just doing this:
they scan parameters.
We also have a lot of people who are just
coming together for some meetings
about these topics to bring their experience."**

*CxO heading the global business unit of a multinational.
company based in Luxembourg*

Photo 14
Luxembourg's Clairefontaine square and Grand Duchess Charlotte statue

Photo © David W. Versailles

Recognizing the relevance of signals and qualifying them as early warning signals is nothing without the ability to gain management attention. Results explicitly show that the organizational drivetrain follows different patterns for the "sensing" and the "seizing" phases. Whatever the firm's size, interviews or survey responses show that getting managers' attention is straightforward, despite the difficulty of zooming out from daily management routines, internal bureaucracy, and short-term-oriented mindsets. Companies that effectively manage signals have found a way to communicate and share information throughout the organization.

"There is no formal process for someone having a good idea. Any soldier or corporal, any sergeant must be able to talk to the general, and tell how to survive the war. There are informal ways to call, meet someone and say: "I have an idea. Can we talk about this?"

CEO in a large bank based in Luxembourg

Our research shows that signal collection ("sensing") remains easier than the qualification of stimuli as "relevant signals" ("seizing"). The most complex stage of the process always relates to the appraisal of corrective actions in due time. This conclusion holds for all firms, with two interesting aspects.

First, managing directors or owners with positions in smaller companies preserve the interpretation of data and the subsequent use of data for strategic adaptation for themselves. When they commission "deep dives" and a better characterization of signals, they often preserve this discussion inside a small team of trusted managers or specialists.

"I have a business analyst who is scanning parameters all day long. He prepares the data. In my organization, I also have a staff of 4-5 people who I'm working really closely with. We discuss a lot to generate the same understanding [of data]."

CEO in an intermediate company based in Luxembourg.

Second, managing directors, owners CxOs and senior managers depend on networking with other similar "senior managers" to discuss signals. This point shows the importance of "third parties" mentioned earlier in this section, most notably when specialized media and institutions also propose arenas for trusted and "neutral" interactions with informed experts or experienced senior managers. The interactions inside networks organized by Chambers of Commerce or organizations supporting startups were referred to by some interviewees as relevant areas for critical discussions about signals.

**"You need to network with people.
I have a lot of people who contact me about
"Oh, have you seen that?"
I'm also well-connected to the Chamber of
Commerce, the different federations, etc.
Using these platforms, you get to know many
people who provide valuable information.
The other channel [towards signals] is just
reading the news."**

CEO in a "young" SME

The role of board members and the debates at such governance levels were mentioned in the questionnaire but never adequately discussed in the project.

The difficulty of generating a big picture was only commented on during interviews and not precisely discussed in the questionnaire, even though 85% of respondents in sub-sample B (66 respondents) claim to look for a broad picture and to insert the analysis of signals into strategic debates for their companies.

**"We also do workshops.
We have extensive workshops with
field managers, frontline managers who
will brainstorm about what problem they see
and who has documented that.
Ahead of our strategic planning, we have
sessions where we exchange on what they see
as problems and potential solutions.
And then we have all of them involved in a
sort of ranking of them."**

CEO of an intermediate firm.

Whatever their sizes, firms in the sample have invented a repartition of signals-related tasks between senior and middle managers.

However, when the company's size increases, and most notably when organizations belong to a multi-national, data collection and the qualification of signals as "early warning signals" is easier because they cover more geographic areas and domains.

Respondents at employee and middle manager levels show frustrations because they are not automatically involved in the steps following their reporting about signals. Formal processes discussing signals only exist in intermediate and large firms. In smaller companies, informal interactions are as much in place for sharing data about signals as for the other activities. Still, whereas employees and middle managers are kept in the loop of the interpretation of early warning signals after collecting them, discussions of "seizing" are heavily monopolized by owners, board members, partners, and managing directors. Other managers (and employees) almost never contribute to conversations about "seizing".

The size of the workforce and the variety of competencies make it possible to process internal appraisals of data that lead to strategic decisions. The interplay between senior and middle managers makes it possible to organize the appropriate collection and appraisal processes inside companies ("sensing" and "seizing") and then enact the appropriate strategic adaptations.

"The most important is not the information itself, or to find information. It's to use information in the proper way."

CxO in an intermediate firm

Sometimes, firms elaborate on information systems and artificial intelligence (one case only). However, this project has underlined that this is still currently reserved for large companies and multinationals. Formalism does not automatically allow for all expected/required flexibility to take better advantage of signals. Interviews and responses to the questionnaire show that it is necessary to introduce a difference between signal collection (that should be pragmatic, and not so formal) and options for signal diffusion inside organizations once detected and qualified (that should be performed with more systematic routines based on comprehensive consideration of all available data). Therefore the relevance of AI, in the future, to overcome the natural limitations of human brains and deliver more timely insights based on large data sets. The main challenge deals here with the volume of available external stimuli and data, and with the necessity to prioritize them

"Most input about signals is free text, which is a big problem. You need someone to analyze it. […] Now, we are hoarding too much data, and we need to get rid of that. […]

CxO in an intermediate company based in Luxembourg.

When zooming out from signals qualified as "early warning signals", interviews show that firms that have implemented codified processes and thus made signals more "digestible" thanks to the use of visualization tools significantly improve the global "sensing" process for all employees and all categories of managers. However, the trade-off between signal codification into information inside IT systems and the flexibility necessary for further "sensing" about signals has not yet been analyzed. It probably represents an autonomous research question.

"We have an IT system that is more or less working. However, IT is more about surviving than plans to evolve. It is also not customized for local issues in each country. So, IT is a problem."

CxO in the subsidiary of a multinational based in Luxembourg.

The large proportion of respondents coming from SMEs and intermediate companies in the sample of interviewees and respondents also leads to other conclusions. It is most likely that the involvement in follow-up actions is not similar in all categories of firms. The staff and available individual competencies matter. Middle managers, operational managers, or employees reporting a signal, explain that follow-up actions exist "sometimes". Only respondents in senior positions always provide a solid "yes" to the existence of follow-up actions when being reported a qualified early warning signal. Consistently with the predominance of SMEs and intermediate firms in the sample, it is also interesting to note that these senior managers do not need any formal meeting to decide about signals and subsequent adaptation actions. Managers who have positions in large firms also show this reaction, yet limited to narrower perimeters of organizational reconfiguration, or business model adaptation.

These elements are not all surprising, but the results of the categories of collected signals are relevant for both researchers and practitioners who aim to improve the management of the "seizing" phase. It is necessary to zoom out from direct behavior data and investigate the links between managerial roles, typical prerogatives, and the categories of collected signals to understand ways of working and phenomena better.

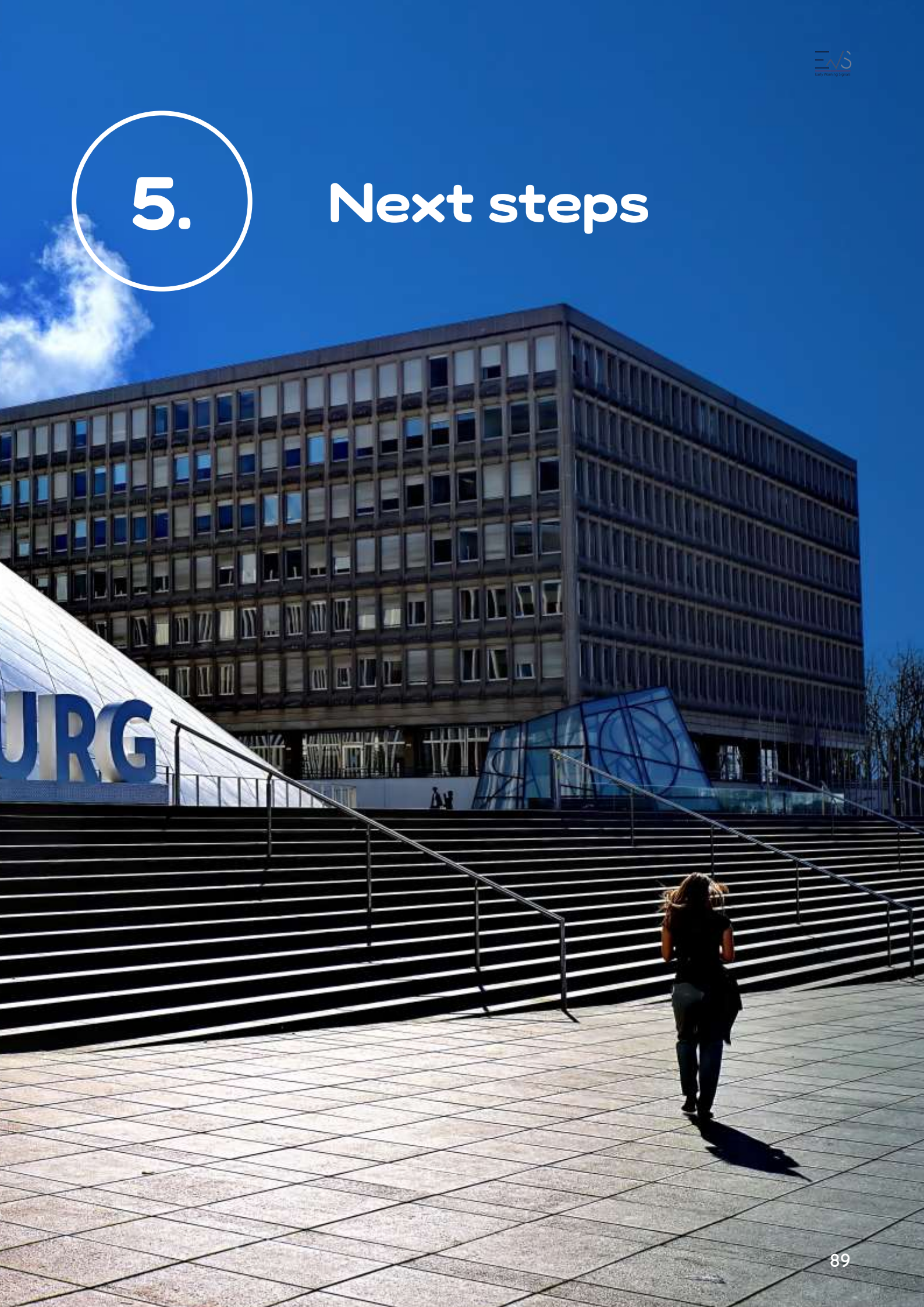
"We were not *per se* prepared,
but we were ready for it."

CxO in an intermediate firm.

Luxembourg
Philarmonie in Kirchberg

Photo © David W. Versailles

5. Next steps



One conclusion prevails. Firms that do not practice corporate foresight or have low foresight proficiency tend to underperform compared to their peers: they miss opportunities because they do not react in due time.

"Anticipate and prepare for change ahead or die."

This motto proposes the best description of the need for the early computation of warning signals in business ecosystems in the 21st century. Lower levels of preparation (preparedness) lead to difficulties when defending or sustaining competitive advantages. Learning to work with early warning signals at individual and collective levels represents a critical distinctive capability explaining the ability to survive in business ecosystems.

However, numerous aspects of the "organizational drivetrain" still need to be documented. Many conceptual and practical questions about early warning signals are still open for research in management science.

The willingness to learn about EWS and transport signals relevant to the "sensing" and "seizing" phases throughout the different layers of an organization is not necessarily equally distributed in every type of company. Therefore, it seems necessary to expand the analysis further and design a new research protocol to investigate these aspects.

The investigation of the questionnaire results has shown that the research protocol requires adaptations and improved calibration to avoid selection biases. This means that greater interaction with local business communities should be encouraged and implemented to ensure that the interview panel and the sample responding to the questionnaire also include enough people who are not *a priori* in favor of collecting and qualifying signals as "early warning signals".

Our research team is currently preparing for an expansion of the research protocol at the "Grande Region" level. This approach will include the composition of an expanded panel of interviewees covering and interacting with the neighboring business ecosystems surrounding Luxembourg. Many French, Belgian, and German cross-border commuters live in these areas. Another step will be to consider other business ecosystems and check how cultural drivers impact the collection and computation of early warning signals.

The Luxembourg School of Business intends to expand the project in the coming months with respect to all these aspects. Anyone interested in supporting the project with interviews, administering the questionnaire, or sponsoring part of the project can contact our team to discuss partnership opportunities.

Luxembourg National Library

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6. List of references

Agassi, Joseph (1975). "Institutional individualism", *British journal of sociology*, 26: 144-155.

Aguilar, F. J. (1967). *Scanning the business environment*. New York: Macmillan.

Ansoff, H. Igor (1975). "Managing strategic surprise by response to weak signals." *California Management Review*. Winter. 18(2): 21-33.

Arend, R. J. (2020). "On the irony of being certain on how to deal with uncertainty." *Academy of Management Review*, 45(3): 702-704.

Barney, J. (1991). "Firm resources and sustained competitive advantage." *Journal of Management*, 17(1): 99–120.

Boisot, Max H. (1998). *Knowledge assets. Securing competitive advantage in the information economy*. New York: Oxford University Press.

Boisot, Max H.; Canals, Agusti P. (2004). "Data, information and knowledge: have we got it right?", *Journal of Evolutionary Economics*, vol 14: 43-67.

Budler, Marko; Zupic, Ivan; and Trkman, Peter (2021). "The development of business model research: a bibliometric review", *Journal of Business research*, 135(Oct.): 480-495.

Cevolini, Alberto (2016). The strongness of weak signals: self-reference and paradox in anticipatory systems." *European Journal of Futures Research*, 4(4): 1-13.

Coleman, James S. (1990). *Foundations of social theory*. Boston, MA: Harvard University Press.

Coleman, James S. (1986). "Social theory, social research and a theory of action". *American Journal of Sociology*, 91: 1309-1335.

Di Stefano, Giada; Peteraf, Margaret; Verona, Gianmario, (2014). "The organizational drivetrain: A road to integration of dynamic capabilities research". *The Academy of Management Perspectives*, 28(4): 307-327.

Felin, Teppo, & Zenger, Todd R. (2017). "The theory-based view: Economic actors as theorists." *Strategy Science*, 2(4): 258–271.

Felin, Teppo; Foss, Nicolai J.; Ployhard, Roy E. (2015). "The micro- foundations movement in strategy and organization theory". *The Academy of Management Annals*, 9(1): 575-632.

Felin, Teppo; Kauffman, Stuart; Zenger, Todd (2021). "Resource origins and search." *Strategic management journal*, Sept, 44(6), 1514-1533.

Fergnagni, Alessandro (2022). "Corporate foresight: a new frontier for strategy and management", *Academy of Management Perspectives*, 36(2): 820-844.

Fergnagni, Alessandro (2022). "Exchange: Corporate foresight. Real or ideal?", *Academy of Management Perspectives*, 36(2): 851-856.

Foss, Nicolai J.; Klein, Peter G. (2012). *Organizing entrepreneurial judgment. A new approach to the firm*. Cambridge: Cambridge University Press.

Foss, Nicolai J.; Saebi, Tina (2017). Fifteen Years of Research on Business Model Innovation: How Far Have We Come, and Where Should We Go? *Journal of Management*, 43(1): 200–227.

Photo 17
“Power breakfast” organized on Dec. 13th, 2022 to present interim results of the EWS project
Photo © David W. Versailles

Helfat, Constance E.; Jaul, Assem; Ketchen, David J. Jr.; Barney, Jay B.; Chatain, Olivier; Singh, Harbir (2023), "Renewing the resource-based view: new contexts, news concepts, and new methods." *Strategic Management Journal*, vol 41(2): 1357-1390.

Kuhn, Thomas S. (1970). *The structure of scientific revolutions*. University of Chicago Press. See in particular the 50th anniversary edition with an introduction by Ian Hacking (4th edition in 2012).

Lachmann, Ludwig M. (1977). *Capital, expectations, and the market process. Essays on the theory of the market economy*. Kansas City, MO: Sheed, Andrews and McMeel.

Marrone, Jennifer A. (2010) "Team Boundary spanning: a multi- level review of past research and proposals for the future", *Journal of management* 4: 911-940.

Merindol, Valerie; Versailles, David W., (2020a). "Boundary spanners in the orchestration of resources: global- lobal complementarities in action". *European Management Review*, 17(1): 101-119.

Merindol, Valerie; Versailles, David W., (2020b). "Orchestrating the conditions for serendipity and innovative networks: the case of open labs". *EGOS annual conference (Hamburg, online conference), track 34*.

Packard, M. D.; Clark, B. B. (2020a). "On the mitigability of uncertainty and the choice between predictive and non-predictive strategy." *Academy of Management Review*, 45(4): 766-786.

Packard, M. D.; Clark, B. B. (2020b). "Probability logic fails in immitigable uncertainty, but strategic logic does not." *Academy of Management Review*, 45(3): 704-707.

Packard, M. D.; Clark, B. B.; Klein, Peter G. (2017). "Uncertainty types and transitions in the entrepreneurial process." *Organization Science*, 28: 840-856.

Porter, Michael E. (1991). "Towards a dynamic theory of strategy." *Strategic Management Journal*, 12(S2), 95–117.

Teece, David J. (2007) "Explicating Dynamic capabilities: the nature and microfoundations of enterprise performance", *Strategic Management Journal* 28: 1319-1350.

Teece, David J. (2017), "Business models and dynamic capabilities". *Long Range Planning*, pp. 1-10.

Versailles, David W.; Foss, Nicolai J. (2019). "Unpacking the constituents of dynamic capabilities: a micro-foundations perspective". *Management International / International Management / Gestion Internacional*, 23(4), 18-29.

Watkins, William W. (1987). "Alienation alienated: the economics of knowledge versus the psychology and sociology of knowledge". Chapter XVIII, pp. 423-451 in Radnitzky, Gerard; Bartley, William W. III (eds;). *Evolutionary epistemology, rationality and the sociology of knowledge*, LaSalle, Ill.: Open Court

Wenzel, M., (2022). "Taking the future more seriously: From corporate foresight to future-making", *Academy of Management Perspectives*, 36: 845-850.

Adolphe bridge

Photo © David W. Versailles

7. Annexes

Data codification

Codification activities use the same references for the interpretation of all data collected in the project. Both approaches investigate the sensing-seizing-reconfiguration framework operated thanks to "weak" or early warning signals and assess the respective activities performed by employees, managers, and governance people (owners, administrators, managing directors, CxOs, etc.). Table 4 lists essential concepts and references in the academic literature used to codify interviews.

The sections about conceptual and managerial issues introduce these concepts and draw connections with the computation and use of "early warning signals."

Table 4
References for data codification

#	Concept	References
	Dynamic capabilities and strategy (Sensing Seizing Reconfiguring); "Organizational drivetrain"	Teece 2007, 2017 Di Stefano, Peteraf, Verona, 2014 Marrone, 2010; Versailles and Foss, 2019
	"Weak" signals and associated perception mechanisms (perceptive and cognitive filters)	Cevolini, 2016; Boisot, 1998 Boisot and Canals, 2004
	Multi-level analysis and micro-foundations approach of dynamic capabilities; Role of managers in the dynamic capabilities	Felin, Foss, Ployhard, 2015 Merindol and Versailles, 2020 Versailles and Foss, 2019
	Business model and strategy making	Teece, 2017; Foss and Saebi, 2017; Budler, Zupic and Trkman, 2021
	Scanning for external drivers of strategy	Porter, 1991
	Scanning for internal drivers of strategy	Barnay, 1991; Helfat et al., 2023
	Entrepreneurs as theorists; Search for resources	Felin and Zenger, 2017; Foss and Klein, 2012 Felin, Kauffman, Zenger, 2021
	Foresight and strategic decision-making Management of uncertainty	Arend, 2020; Wenzel, 2022 Fergnagni, 2022a; 2022b Packard, Clark and Klein, 2017 Packard and Clark, 2020a; 2020b

Source : EWS project

Photo 19
Dino Dogan, Nico Hoffeld and David W. Versailles
during a "power breakfast" organized to present results of the EWS project.
Photo © EWS project

Photo 20
Matteo Forgiarini, Dino Dogan and David W. Versailles attending the 2023 annual Business Model conference in Forlì (Italy) to present results of the EWS project.
Photo © BM Conference 2023

Research Team

This project was supervised and managed by Prof Dr David W. Versailles and Prof Dr Dino Dogan.

David W. Versailles acted as principal investigator and lead researcher, in charge of study conception, literature review, design of field research protocol (sampling, design of interview guidelines and online questionnaire, triangulation and decision for data saturation, design of data storage modalities), and design of data codification framework.

Prof Dino Dogan was the project manager for this research.

The questionnaire was coded with SurveyMonkey by MindForest staff under David W. Versailles' supervision. Data collection (interviews) was operated under David W. Versailles' and Dino Dogan's supervision to ensure continuity and consistency of activities throughout the sample of interviewees.

Data codification was performed under David W. Versailles' supervision with contributions by Dino Dogan, Matteo Forgiarini, Borna Jalsenjak, and Ivan D. Dogan to ensure the critical examination and cross-validation of codification outcomes. 2 rounds of codification were performed. With additional support from Nico Hoffeld, debrief meetings about codification were organized to ensure convergence and consensus about interpreting results between coders.

David W. Versailles and Dino Dogan jointly performed the analysis of qualitative data and the discussion of results. David W Versailles and Matteo Forgiarini jointly developed the analysis of quantitative data.

This White Book was prepared by David W Versailles.

Mrs Jane Barton (MindForest) provided support to project management and the preparation of deliverabes..

Some of the results presented in this White Book have already been presented at the events organized to test interim results in February and December 2022 with interviewees and the Luxembourg business community and at the Business Model conference held in June 2023 (Forli, Italy).

Academic articles are currently under development under David W. Versailles' supervision.

For more information

http://www.dwv.lu

Prof. Dr. David W. VERSAILLES

Prof. Dr. David W. Versailles develops a twin career as an academic faculty and consultant. He is currently the Vice-President in charge of the Dialogue with Practitioners at the European Academy of Management (EURAM). He was previously elected as EURAM chair of the Strategic Interest Group (SIG) on Innovation in June 2022 for the term 2022-2024, thus coordinating the EURAM research community on this research area and organizing all associated tracks and symposia for the EURAM annual conference.

Prof. Versailles is an Ord. Professor and Research director at Luxembourg School of Business, and an Ord. Professor at Paris School of Business in Paris, where he co-heads the “new Practices for Innovation and Creativity” (newPIC) chair with Prof. Dr. Valerie Mérindol.

He holds a Doctorate and the Habilitation to supervise research in economics.

A French citizen residing in Luxembourg, Prof. Versailles is a Founding Partner in ISK Consulting SA (established in Luxembourg in 2017) and the company's managing director.

His research and consulting specializations are in strategic management, the management of innovation, and the methodology of social sciences.

Prof. Versailles is the author of 30+ articles in scientific peer-reviewed journals, edited books, and three books. He is regularly active as a guest editor for internationally recognized academic journals. .

For more information

http://www.dogan-consulting.eu

Dr. Dino DOGAN

Dr Dino Dogan is Dean of the Luxembourg School of Business in Luxembourg and the owner of the business and management consultancy Dogan Consulting.

He has 30 years of practical experience as a consultant and manager (including 15 years in board positions) at Alcatel, Telekom Austria Group, Deutsche Telekom Group, Boston Consulting Group, and JCDecaux Group. He received the European Change Communication Award for the successful merger of Telekom Austria and Mobilkom Austria in 2011.

Dr. Dogan is a lecturer at the Zagreb School of Economics and Management and H-Farm Business School Venice. He has been a lecturer at the economics faculties of the Universities of Stuttgart and Zagreb and the Stuttgart Business Academy. Dr. Dogan is a co-founder of the German International School in Zagreb.

From 2012 to 2014, Dr Dogan was President of the German-Croatian Chamber of Industry and Commerce in Zagreb and is now honorary president of the chamber. He is a member of the advisory board of the ICT company GDi Ltd and a member of the nomination committee of the listed manufacturer of nanosatellites GomSpace Plc.

For more information

http://www.luxsb.lu

LSB Luxembourg School of Business

Luxembourg School of Business

The Luxembourg School of Business (LSB) is the first business school in Luxembourg to be accredited by the Ministry of Research and Higher Education of the Grand Duchy of Luxembourg. LSB offers a range of international undergraduate and graduate business programs.

LSB caters to students at various levels. The undergraduate program, "Bachelor in International Business," is designed for learners who are just starting their careers. For more experienced individuals, LSB offers two master-level programs: "Master in Management" and "Master in International Finance." These programs are tailored for people with some work experience who are looking to further develop their skills and knowledge. The "Master in Management" focuses on general business administration, while the "Master in International Finance" program is aimed at individuals interested in expanding their knowledge in the international finance domain. For experienced professionals looking to advance or pivot in their careers, LSB offers the "Master in Business Administration" (MBA) program.

All of LSB's programs emphasize strong engagement with the business community in Luxembourg and internationally. The school's mission is to provide an inspiring and multicultural learning environment for current and aspiring business leaders from Luxembourg, Europe, and around the world. LSB employs contemporary teaching and research methods to achieve its educational and academic goals, with a focus on promoting cultural and intellectual diversity. Additionally, the school partners with the international business community and prepares learners to succeed in a complex global business environment. .

For more information

http://www.mindforest.com

Engage and Transform with MindForest

Founded in 2000, MindForest is a consulting firm specializing in change management and providing expertise both in the Grand Duchy and internationally.

MindForest collaborates with organisations in both private and public sectors, guiding projects in organisational transformation, engagement and performance improvement, digitalisation, sustainable business change, information design, and AI-impact acceptance and roll-out.

With over 20 years of experience, MindForest places the human factor at the centre of its consulting activities. We emphasise the social and cultural aspects of corporate entities, while prioritising key factors such as commitment, values, corporate culture, experience, social links, communication, emotions, and competencies, not to mention creativity.

Our multi-disciplinary and multilingual team of senior consultants promotes operational excellence by delivering comprehensive and practical solutions. Our in-depth knowledge of the local economic context and diverse industries ensures tailored and effective outcomes. We always address the critical “why” question: Why do we need to change? Why adopt new software? Why upskill? This understanding fosters employee support and smooth transitions.

Our expertise spans four main fields:

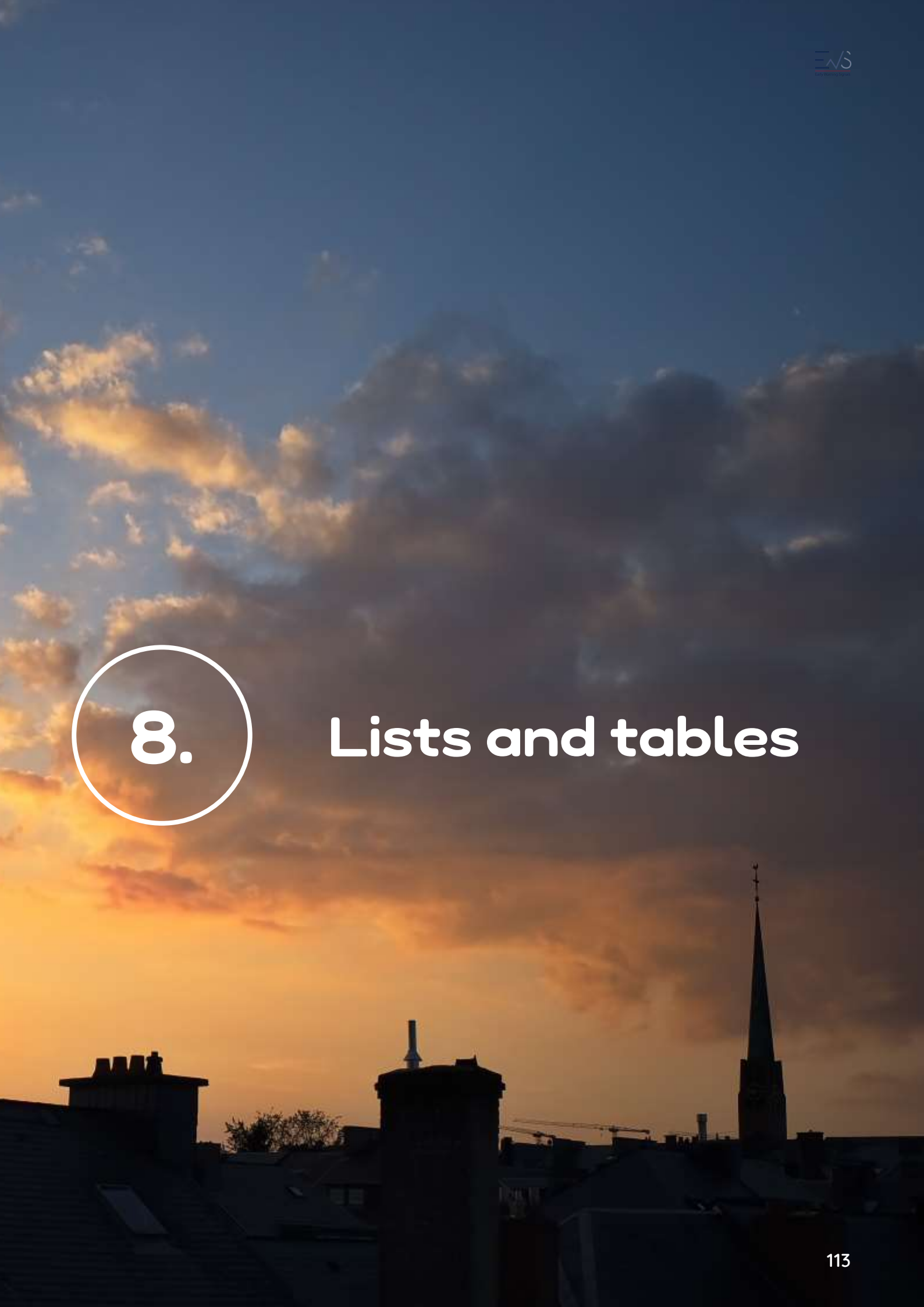
- Vision, Objectives, and Strategy: Crafting clear, actionable roadmaps for organisational success.
- Activation and Adoption: Ensuring seamless integration and acceptance of new initiatives.
- Collective Performance: Enhancing team dynamics and overall productivity.
- Organisational Transformation Driving sustainable, impactful change across all levels.

MindForest’s commitment to integrating transparency, ethics, and advanced technology positions us as a leader in talent optimization and change management. We strive to help organisations become more efficient, competitive, and harmonious.

Discover how MindForest can transform your organisational approach by visiting our website

Sunset above Belair

Photo © David W. Versailles



8. Lists and tables

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Photo 20
The Big Banker statue on Kirchberg's J.F. Kennedy avenue

Photo © David W. Versailles

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Prints available
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and from YellowKorner Luxembourg.

For more information

http://www.dwv.gallery

List of Pictures

The statue of the legendary mermaid Melusina by Luxembourg artist Serge Ecker,

The story of the foundation of Luxembourg City by Count Siegfried in 963 is closely linked to the figure of Melusina the mermaid. When she married Count Siegfried, she stipulated one condition: every Saturday she wanted to be alone in absolute privacy.
Over the years, jealousy overcame the first count of Luxembourg and eventually led him to break his promise. He followed Melusina into her private chambers to secretly observe her taking a bath on the forbidden day. In doing so, he saw Melusina taking a bath and discovered her secret: her bottom half was a fishtail.
When Melusina became aware of Siegfried watching her, she disappeared into the depths of the river Alzette. The count never saw his beloved Melusina again.

Source: https://www.luxembourg-city.com/en/place/monument/melusina-statue

Photo 21
Serge Ecker's 3D printed Melusina statue in the Grund, watching the Alzette river since 2015

Photo © David W. Versailles

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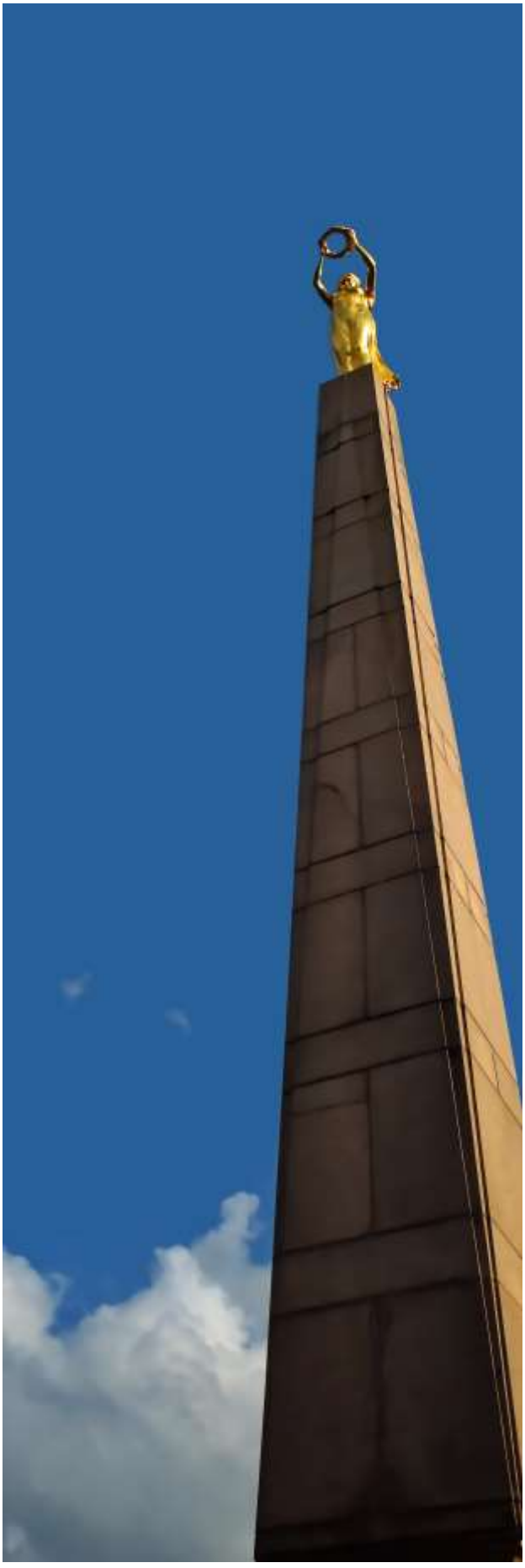

Photo 22
Gëlle Fra
(WW1 and WW2 Memorial)
under the Summer sun
on Constitution square

Photo © David W. Versailles

Luxembourg, May 2024

Early Warning Signals

Be ahead, Be ready

Insights about the use of early warning signals in Luxembourg's business community

David W. VERSAILLES

With contributions by Dino DOGAN, Matteo FORGIARINI, Borna JALSENJAK, Ivan Dino DOGAN, Nico HOFFELD, and Jane BARTON

In today's markets, the frequency of change and the corresponding impact on firms constantly increases. A reactive mode is no longer appropriate. Discontinuities and strategic surprises do not emerge without warning. "Early Warning Signals" (EWS) comprise part of the environmental scanning required for the elaboration of corporate strategy. The missing link lies in collecting data and "noises" emitted by the market or the macroscopic environment and their proper qualification as EWS.

To fill this gap, it is important to acknowledge that there is nothing weak in the signal itself. What is weak is the attention paid to the signal. The qualification of EWS depends on the ability to work as "searchlights". It does not deal with "knowing the unknown", but with "*navigating the unknown*". There is no "right" or "wrong" foresight, only *better* foresight.

This research acknowledges the importance of EWS in all companies, big or small. It improves the understanding of the "sensing" and "seizing" phases of business model adaptation and proactive management of risks and disasters. The different categories of managers do not devote the same attention to the different categories of signals. Responses to the questionnaire and interviews show that a broad range of ways of working exist in the different categories of firms to manage signals. Interviews always stress the importance of active listening. Pragmaticism prevails with respect to the selection of signal sources. Signal interpretation ("seizing") is more difficult than signal collection ("sensing"), and less complex than the appraisal of actions for strategic adaptation. Ways of working for the "sensing" and the "seizing" differ in SMEs, intermediate companies, and large firms. The formalism of interactions increases with the size of firms, even thought oral communication remains the most effective way to transport signals. Initial leads about the role of IT and AI are also available for the "sensing" and "seizing" of EWS.

White Book available for download from: http://www.ews.lu

DOI: TBD

Luxembourg, May 2024

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