Strategic interpretation on sustainability issues – eliciting cognitive maps of boards of directors

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Abstract

Purpose – *The purpose of this paper is to examine the role of cognitive diversity on strategic issue interpretation among the boards of directors making sense of sustainability management. The study also investigated the centrality of the corporate sustainability issues to identify common interpretative patterns in the shared cognitive maps among the companies. In addition, the aim was to advance quantitative methods for the analysis of decision-makers' cognition.*

Design/methodology/approach – *The research was an exploratory study analyzing 43 individual cognitive maps collected through surveys from the boards of nine cleantech companies. For the elicitation of the cognitive maps, the study used the hybrid cognitive mapping technique. The diversity of the shared cognitive maps was analyzed using the distance ratio formula and the graph analysis method with eigenvector to measure the centrality of the strategic issue interpretation in the maps.*

Findings – *This study provides evidence through the analysis of distance ratios on the existence of cognitive diversity among companies within the same industry. Surprisingly, despite the cognitive diversity, the study identified strong common patterns on strategic issue interpretations among the companies. In addition, the study shows that the sustainability management issues have gained minor attention from the boards of directors.*

Research limitations/implications – *The initial industry sample provided relatively restricted perspectives on managerial cognition, and to confirm the findings regarding the effects of industry on the shared cognitive maps of top decision-makers, wider industry-level data are needed.*

Practical implications – *This study provides an approach to facilitate the process of strategic decision-making for top decision-makers by identifying the shared beliefs of the selected strategic theme and to concentrate on the most central strategic issues in the company and industry. It reveals asymmetry between the significance of sustainability issues in an open agenda and the real position of sustainability concepts in the shared cognitive maps in the green industry. Also, the study advances cognitive mapping techniques for application in the board's decision-making.*

Originality/value – *This paper contributes to brightening the black box of corporate governance by shedding light on the interaction of the concepts of corporate sustainability and other key strategic issues within the shared cognitive maps of the boards. It also provides new empirical knowledge on top decision-making processes and the effects of cognitive diversity on the strategic issue interpretations within the corporate boards of the green industry, and it further develops the methodology for the quantification of cognitive diversity and the content of cognitive maps.*

Keywords *Boards of directors, Sustainability, Cognitive mapping, Cognitive diversity, Distance ratio, Issue interpretation*

Paper type *Research paper*

1. Introduction

When operating in a rapidly developing and emerging business environment, such as the cleantech industry, cognitive limits and strategic issue interpretation become important factors in organizational decision-making (Bogner and Barr, 2000; Nadkarni and Narayanan, 2007). Decision-makers and organizations do not pursue action against

environmental stimuli, *per se*. They respond to such issues that meet their previous experience (Simon, 1959; Weick, 1995; Tuggle *et al.*, 2010) and are advocated by internal or external meaningful stakeholders, e.g. sustainability directives set by the European Union commission (Ocasio, 1997; Bundy *et al.*, 2013). Thus, strategic decision-makers focus on issues that are perceived as having a potential impact on the organization and their stakeholders and that resonate the goals of the organization (Zollo *et al.*, 2009). Boards of directors, which are intermediaries between their organization and the complex business environment, continuously make sense of the environmental stimuli they receive in a situation of information overload. Individual cognitions shared among the peers create stable and repeatable patterns of collective frames, enabling receiving and interpreting strategic information (Narayanan *et al.*, 2011).

These cognitive structures are mechanisms that filter the strategic issues and claim them in a certain context and purpose (Walsh, 1988; Forbes and Milliken, 1999; Kilduff *et al.*, 2000). Within these cognitive frames, board members prioritize issues based on how they affect the organization's strategy and goals, and the diversity of strategic issue interpretation follows this process. Cognitive diversity in these frames may cause inertia within a group and the organization to achieve the final agreement for action and diminish organizational responsiveness to environmental changes (Markoczy, 2001; Kellermanns *et al.*, 2005; Marcel *et al.*, 2010). On the other hand, cognitive similarity may cause blindness to emergent opportunities and threats in the business environment (Sutcliffe and Huber, 1998; Markoczy, 2001; Bingham and Eisenhardt, 2008). Thus, cognitive diversity shapes the organizational interpretation process by enhancing as well as limiting its members' abilities to categorize and conceptualize their environment (Grandori, 1997; von Krogh *et al.*, 2000; van Ees *et al.*, 2009).

The cognitive mapping technique allows for studying cognitive frames inaccessible through direct observation (Hodgkinson *et al.*, 2004). In this exploratory paper, the gap in understanding the relationship between cognitive diversity and strategic issue interpretation that still persists in spite of recent research on managerial cognitive processes is addressed. The empirical analysis of this study examined 43 individual cognitive maps collected through a survey method from the boards of directors of nine cleantech companies regarding strategic sustainability issues. The article is organized as follows. First, the strategic cognition literature is reviewed to explain the cognitive diversity in decision-making groups and the role of shared cognitive structures of interpretation in the context of the board of directors. The hybrid cognitive mapping technique and the graph analysis method with an eigenvector centrality measure that was applied to analyze cognitive maps and identify common patterns in strategic issue interpretation among the companies is then discussed. Finally, concluding remarks and suggestions for the future research avenues are provided.

2. Theoretical background

2.1 Cognitive diversity

The cognitive research in strategy management studies is based on Simon's (1955) notions concerning the capacity of human cognition relative to the requirements of information environments in which the individuals perform:

> Classical theory is a theory of a man choosing among fixed and known alternatives, to each of which is attached known consequences. But when perception and cognition intervene between the decision-maker and his objective environment, this model no longer proves adequate (Simon, 1959).

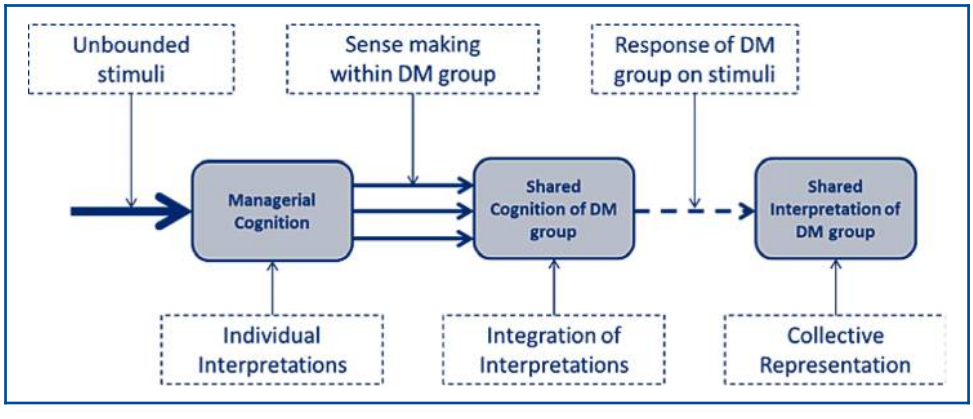
On a collective level, shared cognitive frames refer to a system of fundamental strategic cause–effect beliefs and priorities that are embedded in an organization's routines and processes that shape the strategy implementation to meet the changing environmental requirements (Stubbart, 1989; Powell *et al.*, 2011; Sur, 2014). The cognitions of

decision-makers develop in a continuous interplay of a context, wherein persons such as a group, organization or industry act and the previous experiences that guide their cognitive orientation into predetermined goals (Nelson, 2008). In each decision-making context, a large number of cognitive attributes constrain individuals' interpretations, creating cognitive diversity among members of an organization (Klimoski and Mohammed, 1994). Directors also have different experiences, knowledge bases, motivations and social contexts, which shape their interpretative abilities (Forbes and Milliken, 1999; Sur, 2014). Within these boundaries, decision-makers develop subjective interpretations of their environment that directly affect an organization's strategic priorities and actions (Ocasio, 2011; Bocken *et al.*, 2013). Based on this social cognitive perspective, cognitive diversity between individuals is a result of dissimilarities in backgrounds, values, beliefs and preferences among peers within an organization, reflecting the variation in preferences in goals and cause–effect relations in their interpretations.

Despite the necessity of cognitive diversity, shared cognitions are imperative in organizational decision-making (Lyles and Schwenk, 1992). During the interactive sense-making process, heterogeneous cognitions are integrated and enacted in decision-making groups for a certain purpose, such as sustainability strategy development. Thus, a group's collective interpretation depends not only on the information available but also on the integration of diverse cognitions among fixed and known alternatives, as shown in Figure 1 (Hambrick and Mason, 1984; von Krogh *et al.*, 2000; Sur, 2014).

In organizations, top-level decision-makers act as strategic knowledge processors who filter, interpret and utilize information from inside and outside the organization (Hambrick and Mason, 1984; Prahalad and Bettis, 1986). Here, board members distribute their personal knowledge, beliefs and goals among interdependent members of a group, creating diversity on issue interpretation in a certain context (Forbes and Milliken, 1999; Bergman *et al.*, 2007, 2015; Nadkarni and Barr, 2008) and relying on the repertoire of stored cognitions in their memories (Forbes and Milliken, 1999; Grandori, 1997). Such shared belief structures are cognitive templates that reflect how decision-makers conceptualize the environment and how they categorize the strategic issues within it (Daft and Weick, 1984; Dutton and Duncan, 1987). Over time, shared cognitions store the strategic repeatable behavioural patterns of the organization that channel decision-making groups' attention to the issues that are relevant to the strategy and goals of the organization (von Krogh *et al.*, 2000). As decision-makers have a limited information processing capacity (Simon, 1959), the utilization of collective cognitive diversity determines how the business environment is interpreted and which strategic issues become salient for the organization (Dutton and Duncan, 1987).

Figure 1 The general interpretation process in a decision-making group



2.2 Board as a locus of cognitive diversity

Since the seminal works of Fama and Jensen (1983) and Zahra and Pearce (1989), strategy has been seen as one of the critical board roles, although it is complicatedly intertwined with other board functions, such as service and control. Baysinger and Hoskisson (1990) isolated strategic control within the decision control function of the board, as emphasized by Fama and Jensen (1983). According to Johnson *et al.* (1996), the service role involves directors advising the CEO and top managers as well as more actively initiating and formulating a strategy. Hence, the role of the board as a top decision-making body and as the pivotal corporate governance mechanism has also been stressed in the perspective of external stakeholders, especially regulators and investors (Lawler *et al.*, 2002; Daily *et al.*, 2003; Ararat *et al.*, 2015).

In this strategic role, as an intermediary between the organization's internal and external environment, the board faces the challenge of making complex decisions under uncertainty and bounded information to even a greater extent than corporate executives. To process incoming information, boards utilize their perceptual filters, i.e. cognitive frames to reduce uncertainty and complexity (Hambrick and Mason, 1984; Rindova, 1999; Sur, 2014). The more uncertainty that exists in the available information, the more the board's decisions move from discrete economic reasoning to boundedly rational cause–effect interpretations, creating diversity in decision-making processes (Grandori, 1997). The composition of the board being a sum of the characteristics of individual members is an important factor that gives limits for its behaviour and outcomes (Ameer *et al.*, 2010; van Ees *et al.*, 2009; Adams *et al.*, 2015). The research on board composition has intensively investigated the role of CEO (Fama and Jensen, 1983; Quigley and Hambrick, 2012), internal versus external directors (Fama and Jensen, 1983; Eisenberg *et al.*, 1998), gender and other demographic backgrounds (Burke, 1998; McIntyre *et al.*, 2007; Miller and Triana, 2009) and has reported positive effects of team diversity on team and organization performance as a source of wider and richer information for collective use in boards' decision processes (Ameer *et al.*, 2010). In addition, van Ees *et al.* (2009) have also found that more emphasis on boards' interactive decision-making processes and individuals' cognitive abilities may provide a deeper understanding of boards' behaviours and performances.

Considering the board as an information processing workgroup in organizational decision-making, Bettenhausen (1991, p. 346) has defined such workgroups as "intact social systems that perform one or more tasks within organizational context". Based on this notion, Forbes and Milliken (1999, p. 492) stated that boards are decision-making groups that trace complex tasks and process strategic-issues, and because they are not involved in implementation, "the 'output' that boards produce is entirely cognitive in nature"; however, such boards always have power to ratify the strategic decisions of top-level managers (Fama and Jensen, 1983) and play a key role of intermediary between the external and internal business environment, providing ongoing advice and operative frames to top managers on possible strategic changes (Carpenter and Westphal, 2001). Initially, only executives who also served on the board of directors were identified as top management team members (c.f. Finkelstein and Hambrick, 1990; Haleblian and Finkelstein, 1993; Norburn, 1989; Carpenter *et al.*, 2004). Researchers who have adopted an opposing view and have placed the board of directors outside the limits of the top management team still emphasize that under a given approach outside the control of the team, there are more potential influences on organizational performance, such as the board as well as the industry (Beal *et al.*, 2003; Barrick *et al.*, 2007). Geletkanycz and Hambrick (1997) emphasized the direct influence of the external members on organizational strategy. They stated that their influence through the provision of important information, legitimacy and other resources are the most pivotal actors residing outside of the immediate team boundaries (Carpenter *et al.*, 2004).

The boards of directors have always been a challenge for empirical data collection that conditioned their position on the top of the company hierarchy and on the boundaries of the top management team as well as of the organization itself. When selecting corporate sustainability as a domain embedded in sustainable development dimensions, companies must change their values, strategies and businesses models (Ricart *et al.*, 2005) and allow researchers to capture boards' strategic interpretations through their shared cognitions.

3. Methodology

3.1 Research setting

The research objective was to examine the role of cognitive diversity in strategic issue interpretation among the boards of directors. The unit of analysis is the board, but the levels of analysis are the organization and the industry. The complexity of the board as the unit of analysis determined the type of analytical framework used in the research. To cope with the complexity, it was assumed that the board comprises individuals rather than the organizations they represent.

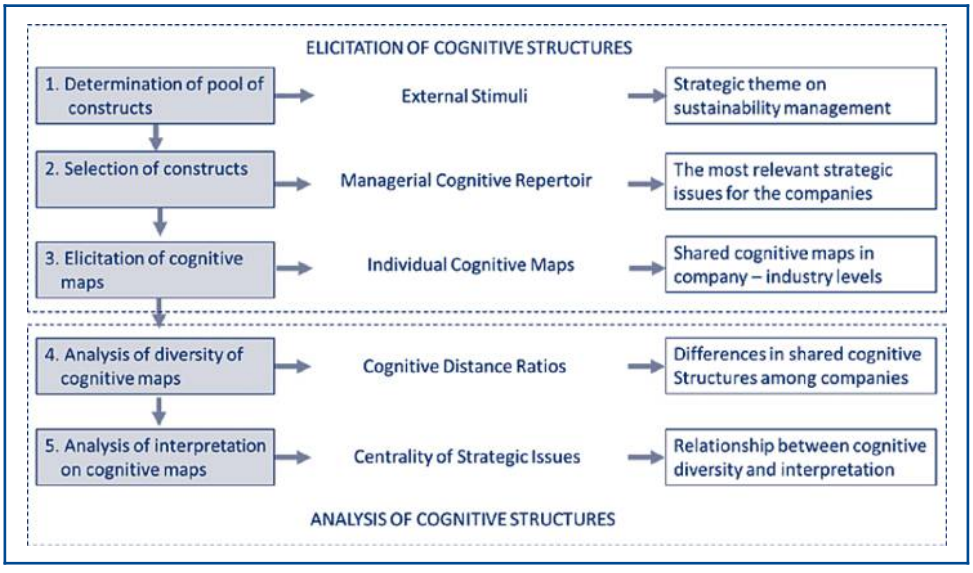
As the interest in sustainability and its role in companies' strategies has gained increasing attention among practitioners and management scholars (Russo and Fouts, 1997; McWilliams and Siegel, 2001; Epstein and Roy, 2001; Baumgartner and Ebner, 2010; GRI, 2011; Lee and Farzipoor, 2012; Garza, 2013; Edgeman, 2013; Galphin *et al.*, 2015), in this study, the manner in which company boards make sense of sustainability issues based on the observed patterns of strategic interpretation among the companies was investigated. Our initial sample of companies was based on the OECD and national classification of the cleantech cluster in Finland (Sitra) representing the cleantech industry sample. The companies were selected from different business sectors within the industry to establish a cognitive diversity between them. All companies publicly identified themselves as actors within the cleantech cluster. From the nine selected companies, one was a publicly owned regional energy production company (A), one was an investor-owned energy production company (E) operating in Nordic countries, three were original equipment manufacturer (OEM) companies in the energy sector (B, F, H), three were component manufacturing companies (D, C, G) operating globally and one was a financial service company (I). All companies had been gaining a significant share of their turnover from cleantech cluster operations. After the selection of the companies, each chairman of the boards of directors was contacted personally to agree to the participation of all members of the boards in the survey. The number of the members of the boards varied from three to seven directors per company, resulting in 43 respondents altogether.

3.2 Method

This exploratory study approached the cognitive diversity on strategic issue interpretation within the boards of directors from the social–cognitive perspective. Figure 2 shows the main phases of the elicitation and analysis process of managerial cognition and interpretation (Markoczy and Goldberg, 1995; Langan-Fox *et al.*, 2000; Tegarden *et al.*, 2009; Bergman *et al.*, 2014).

For the data collection and elicitation of decision-makers' cognitive maps, nomothetic and ideographic causal mapping techniques were combined (Axelrod, 1976; Bougon, 1992; Eden and Ackermann, 1992; Langfield-Smith and Wirth, 1992; Hodgkinson *et al.*, 2004). To analyze cognitive diversity among the companies, the Markoczy and Goldberg (1995) formula was used for computing the non-metric distance ratios as an indicator of similarities on shared cognitive maps. Then, an influence analysis was conducted on the created company- and industry-level shared cognitive maps using the graph analysis method with the eigenvector centrality measure (Bonacich, 1972; Knoke *et al.*, 2008; Bastian *et al.*, 2009; Abraham and Hassanien, 2012) to reveal common patterns of interpretations on strategic issues among the companies. Finally, the relationship between the diversity of the shared cognitive maps and the strategic issue interpretation was examined.

Figure 2 The general phases of the elicitation and analysis process of cognitive maps

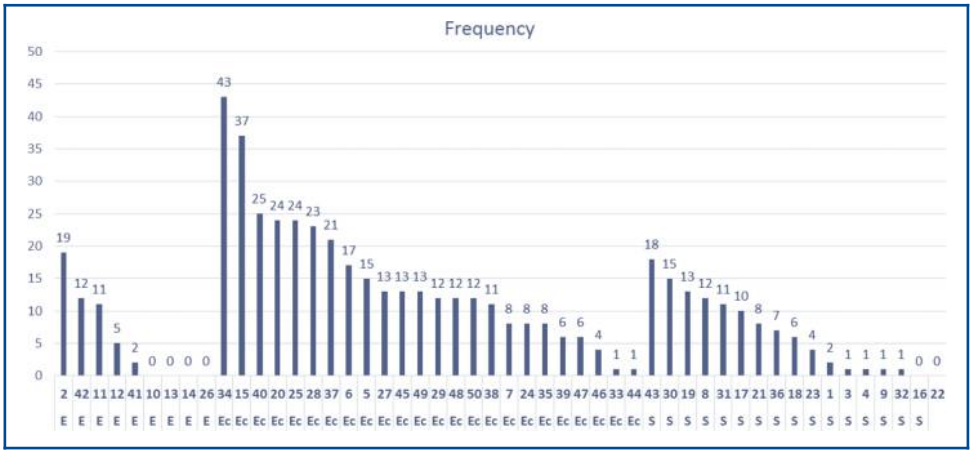


3.2.1 Determination of the pool of constructs. The initial framework of the relevant strategic issues on sustainability management for the companies was developed using the relevant strategy management literature. The issues were classified into economic, environmental and social categories conceptualizing strategic sustainable management. Next, the preliminary list of issues was sent to two chairs of the boards to confirm the completeness and vocabulary. The final list included the 50 most relevant corporate sustainability issues for the selection (Appendix 1).

3.2.2 Selection of constructs. The final list of the strategic issues was analyzed independently by each respondent. They also received a short description of the methodology and the aims of the study. Each respondent selected the 12 most relevant issues for their company from the list to create cognitive maps in the next phase (Figure 3). They also had an opportunity to complete the list by naming two additional relevant issues in their own cognitive maps.

This phase illustrated how the directors pay attention to external stimuli by selecting the most relevant strategic issues for the companies (Dutton and Duncan, 1987; Ocasio, 1997; Markoczy, 2001). In Figure 3, the frequency of the strategic issues by category shows

Figure 3 Frequency of the strategic issues in the industry-level cognitive map



which issues gained the most attention of the directors in their information environment. From the list of strategic issues (Appendix 1), six issues were recognized to not have relevancy for the companies, which were social and environmental issues, even though all issues were claimed to be important in the literature and in the discussions between the researchers and the test companies' representatives (chairs of the boards). The remaining issues were recognized 516 times by the board members showing the strategic relevancy for the companies.

In Figure 3, it can be seen that the economic issues dominate the directors' attention as the most labelled issues. The economic issue (*34) Long-term profitability* gained the attention of all directors. Considering the sustainability management issues, the most frequently recognized sustainability management issue is (2) *Use and development of environmental friendly technologies in products*; however, the social category issues gained the strongest attention from the directors, such as (43) *Leadership in organizations*, (30) *Corporate governance* and (19) *Health and safety of citizens*. This does not yet demonstrate the influence of the issues in the companies' strategies. Despite the high frequency rate, the issue may play either a central or minor role in the cognitive maps. To determine the most central issues for the companies, it is necessary to examine the influence of the diversity of the top decision-makers' cognitions on strategic issue interpretation.

3.2.3 Elicitation of cognitive maps. Next, to identify respondents' cognitions and strategic issue interpretations, the respondents drew a causal diagram by hand using 12 issues selected from the list of constructs. The respondents were asked to evaluate the influence of each issue (node) on his/her other selected issues, i.e. determine the cause–effect relationships and draw a line (arc) between the nodes. The line between the nodes identifies the polarity/direction of the influence and the strength of each relationship. The influence between the nodes could be either negative (−) or positive (+), and the strength ranged from weak (1), moderate (2) or strong (3). This phase resulted in 43 individual cognitive maps, including 12 constructs and their cause–effect relationships in a diagrammatic form, as shown in Appendix 2.

3.3 Analysis and results

3.3.1 Diversity of shared cognitive maps. The diagrammatic presentations of the cognitive maps were converted into the association matrices (Appendix 2). Then, each individual matrix was summarized and equalized as extended matrices (100 × 100) presenting the shared cognitive map of the board (Appendix 3). Finally, the distance ratios for each cognitive map of the board members were computed using the Markoczy and Golberg formula [equation (1) in relation to the shared cognitive maps of the companies and the industry sample (Bergman *et al.*, 2014). Mathworks Matlab R2013a software was used to compute the distance ratios programming in the presented equation (1):

$$DR_1(A, B) = \frac{\sum_{i=1}^{p} \sum_{j}^{p} diff(i, f)}{(\epsilon\beta + \delta)p_c^2 + \gamma'(2p_c(pu_1 + pu_2) + pu_1^2 + pu_2^2) - \alpha((\epsilon\beta + \delta)p_c + \gamma'(pu_1 + pu_2))} \quad (1)$$

where:

$$diff(i, j) = \begin{cases} 0, & \text{if } i = j \text{ and } \alpha = 1 \\ \Gamma(a_{ij}, b_{ij}) & \text{if } i \text{ or } j \notin P_c \text{ and } i, j \in N_A \text{ or } i, j \in N_B \\ |a_{ij} - b_{ij}| + \delta & \text{if } a_{ij}b_{ij} < 0 \\ |a_{ij} - b_{ij}| & \text{otherwise} \end{cases}$$

and:

$$\Gamma(a_{ij}, b_{ij}) = \begin{cases} 0 \text{ if } \gamma = 0 \\ 0 \text{ if } \gamma = 1 \text{ and } a_{ij} = b_{ij} = 0, \\ 1 \text{ otherwise} \end{cases} \qquad \gamma' = \begin{cases} 0 \text{ if } \gamma = 0 \\ 1 \text{ otherwise}, \end{cases}$$

Where A and B are two extended association matrices, a_{ij} (or b_{ij}) is the value of the ith row and jth column of A (or B), and where p is the total number of possible nodes, P_c is the set of nodes common to both maps, p_c is the number of such nodes, p_{u1} is the number of

nodes unique to map A and p_{u2} is the number of nodes unique to B. N_A and N_B are the sets of nodes in the maps A and B. $\alpha,\beta,\gamma,\delta,\varepsilon$ are the parameters described by Markoczy and Goldberg (1995).

First, the individual cognitive maps were aggregated into company levels, creating extended association matrices to compute the distance ratios [equation (1] for the shared cognitive maps of the companies (Bergman *et al.*, 2014). Then, the distance ratios were compared between the companies (Table I).

As shown in Table I, the companies' shared cognitive maps vary, indicating differences in the cognitive maps among the companies. If the companies are arranged according to which are closest to company B, we have the ranking $B \prec F \prec C \prec E \prec A \prec H \prec D \prec G \prec I$ with DR_1. With this information, how close the interpretations on sustainability management issues of the companies are can be described, and potential similarities on cognitive outcomes can be evaluated, i.e. cognitive maps.

To continue into the industry-level cognitive map, distance ratios were computed for each company from the industry map, i.e. from all board members of nine companies. Table II presents distances between the companies' maps and industry map.

Now, we are able to examine how close each company's cognitive map is to the industry-level shared cognitive map. This information allows for evaluating the industry-level interpretation of the business environment and positioning the companies in relation to the industry. If we rank the companies according to distances (Table II), the ranking $C = A \prec H \prec F \prec B \prec D \prec E \prec I \prec G$ with the distance DR_1 shows that companies A and C are the closest to the industry map, and company G is the farthest from it. As an implication, for example, company G may have the potential to respond on sustainability management requirements advocated by the business environment the most differently compared to other companies, providing a competitive advantage for it. On the other hand, the high distance from the industrial shared cognitive map may indicate the company's limited interpretative abilities, leading to blindness of opportunities/threats. Also, in Table II, it can be seen that the distances of both companies' C and A shared cognitive maps from the industry-level shared cognitive map are equal, $DR_1 = 0.096$. As noticed, companies C and A's cognitive maps are as far from the industry cognitive map, and they may have a number of similarities in their cognitive maps that lead them to similar cognitive outcomes; however, it does not mean that they have equal cognitive maps (Table I).

3.3.2 Strategic interpretation on shared cognitive maps. To understand the relationship between cognitive diversity and strategic issue interpretation, the contextual similarities of the shared cognitive maps among the companies was analyzed next.

Table I Distances of companie's cognitive maps to other companie's cognitive maps

Company	*Distance measure*	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*
A	DR_1	0	0.1787	0.1156	0.1277	0.1195	0.0983	0.1513	0.1310	0.1340
B	DR_1	0.1787	0	0.1543	0.1948	0.1773	0.1479	0.2032	0.1892	0.2338
C	DR_1	0.1156	0.1543	0	0.1034	0.1065	0.1221	0.1566	0.1171	0.1730
D	DR_1	0.1277	0.1948	0.1034	0	0.1304	0.1300	0.1494	0.1516	0.1468
E	DR_1	0.1195	0.1773	0.1065	0.1304	0	0.1011	0.1441	0.1472	0.1249
F	DR_1	0.0983	0.1479	0.1221	0.1300	0.1011	0	0.1407	0.1083	0.1106
G	DR_1	0.1513	0.2032	0.1566	0.1494	0.1441	0.1407	0	0.1909	0.1886
H	DR_1	0.1310	0.1892	0.1171	0.1516	0.1472	0.1083	0.1909	0	0.1278
I	DR_1	0.1340	0.2338	0.1730	0.1468	0.1249	0.1106	0.1886	0.1278	0

Table II Distances of company- to industry-level map

Distance ratio	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*
DR_1	0.0599	0.0693	0.0599	0.0703	0.0728	0.0624	0.0815	0.0609	0.0757

In the analysis of the shared cognitive maps, the eigenvector centrality measure for each issue was computed to identify issues that play a central role in board members' cognitive maps as networks of causalities (Bonacich, 1972, 2007). The shared cognitive maps of the boards, i.e. extended association matrices, were translated to and visualized as graphical presentations of causal networks, and the relative influence of strategic issues (nodes) in the graphs was estimated (Abraham and Hassanien, 2012; Knoke *et al.*, 2008). In the graphs, the most influential issues (nodes) and the strength of causalities (lines) between the groups of nodes and repeating patterns of connections within the shared cognitive maps were identified.

Compared to simpler geometrical measures, such as degree of centrality, the eigenvector centrality also considers the influence of the connected nodes and takes into account the entire pattern of the graph. Where the degree of centrality gives a simple count of the number of connections a node has, the eigenvector centrality assigns higher values to connections to higher-ranking nodes (Newman, 2008). For example, with this calculation method, a node with few high-ranking connections might outrank a node with a larger number of low-ranking connections. Because of the calculation method, the eigenvector centrality measure gives reliable results in graphs composed only of strongly connected components (Boldi and Vigna, 2013).

For the centrality analysis, Gephi 8.1 Beta Software and the Force-Atlas algorithm was used to create the graph, taking into consideration the relative importance of the nodes computing eigenvector centrality measures for a given node using equations (2) and (3) (Newman, 2008; Bastian *et al.*, 2009; Jacomy, 2012). In the equations, if one denotes the centrality of node i by x_i, then one can allow for this effect by making x_i proportional to the average of the centralities of i's network neighbours:

$$x_i = \frac{1}{\lambda}\sum_{j=1}^{n} A_{ij}x_j, \tag{2}$$

Where λ is a constant. Defining the vector of centralities $x = (x_1, x_2, \ldots)$, one can rewrite this equation in matrix form as:

$$\lambda x = A \cdot x, \tag{3}$$

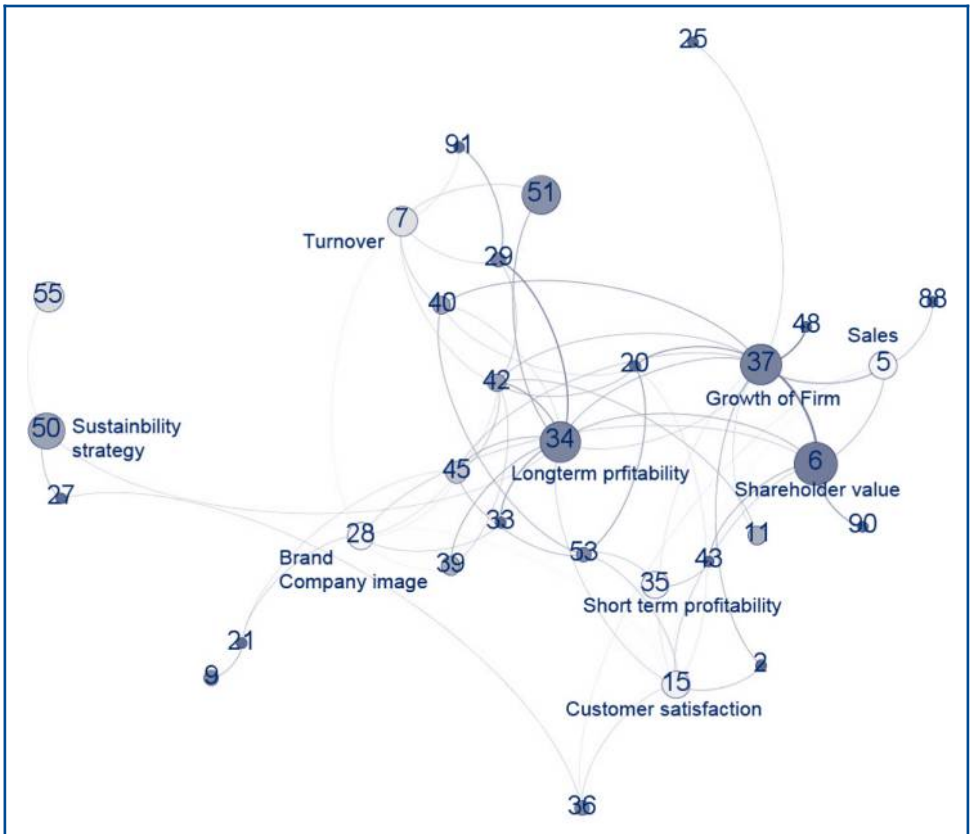
Where x is an eigenvector of the association matrix with eigenvalue λ.

Now, the centrality analysis of the shared cognitive maps was conducted on two levels: company and industry levels. On the company level, the analysis provided a graph visualization that showed the centrality of the issues in the shared cognitive maps of each board of directors. (Figure 4). On the industry level, the centrality analysis revealed common interpretative patterns on strategic issues among the companies' shared cognitive maps (Figure 5, Appendix 4). Each node in the graphs represents a strategic issue in a shared cognitive map, and the edges (lines) connecting the nodes represent causalities that occur between each individual strategic issue. The relative size and colour of the nodes are based on the eigenvector centrality [equations (2) and (3)], showing the centrality of the issue.

The visualization of the centrality analysis makes it possible to recognize the most influential issues and the existence of common patterns in strategic issue interpretations among the companies. In Table III, from the graph analysis, all strategic issues in the shared cognitive maps of the companies and the industry were ranked according to eigenvector values (Appendix 5), describing the centrality of the strategic issues in the shared cognitive maps (top 20 issues shown in Table III).

As shown in Figure 3, some issues have been noticed frequently by the board members, but they have not achieved a central role in the shared cognitive maps. Table III shows that the directors perceived economic issues as the most central issues in sustainability management, e.g. (34) *Long-term profitability*, (37) *Growth of the firm* and (6) *Shareholder value.* Also, the issue (28) *Brand, company image* is perceived as central. The centrality of

Figure 4 Centrality of the strategic issue interpretation in the shared cognitive map of company F

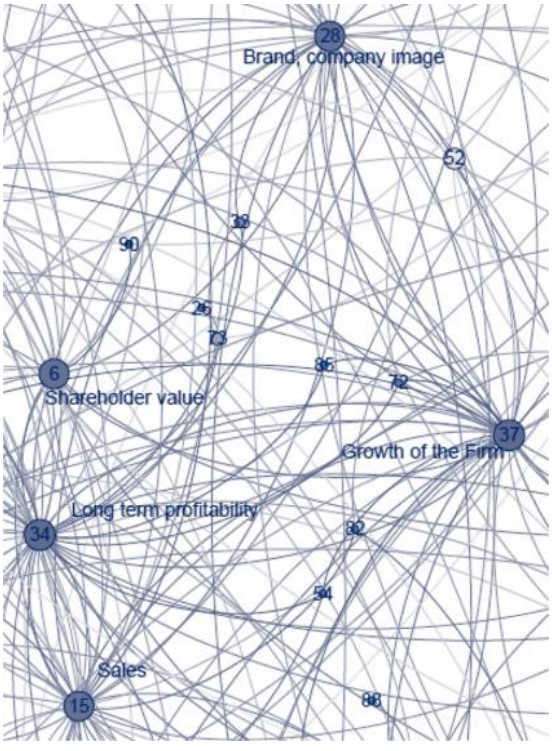


Note: The red color and large size demonstrate a very central role

issue (28) may reflect the increasing importance of sustainability issues among the companies' stakeholder networks. Considering the sustainability issues, the most central issues belonged to the social category (31) *Ethical behavior and human rights* and (36) *Employees attitude*. The first highly central environmental issue was (2) *Use and development of environmental friendly technologies in products*. The results show that to become central in boards' interpretations, an issue should first gain the attention of individual directors (Figure 3) and then should be interpreted as an influential issue among the directors, demonstrating its value to the company's strategy (Table III) (Dutton and Duncan, 1987; von Krogh *et al.*, 2000).

By comparing companies' shared cognitive maps and their backgrounds, some similarities were observed between their interpretations on sustainability management issues. The issue (11) *Energy use of products and services* was considered to be central in the OEM companies *C, E, F, G*. Also, the issue (12) *Resource overuse* was recognized as central by the OEM companies *B, C*. A surprising result was that the issue (2) *Use and development of environmentally friendly technology in products* was perceived as central by all of the companies except the OEM companies. Instead of this issue, the OEM companies *A* and *F* stressed the role of equation (42) *Technology expertise in renewables*. In company *I*, the directors perceived the social category issues the most central as (*17) Employee training and education, (23) Wages and benefits of employees, (30) Corporate governance (transparency, following rules/regulation) and (36) Employees' attitude*. The company operates in the financial sector, and the technological as well as environmental issues may have a very minor role in their business processes. The results indicate that some issues

Figure 5 Centrality of the strategic issue interpretation in the shared cognitive map of the industry (complete graph in Appendix 4)



gain attention by the directors but have very weak or no influence on companies' strategies, achieving minor role in the shared cognitive frames.

3.3.3 Relationship between cognitive diversity and interpretation. Next, to identify the similarities in the interpretative patterns among the companies, the Spearman's rank correlation coefficient [ρ] was computed for the ranked strategic issues (Appendix 5). The Spearman's rank ρ shows the correlations between the companies' issue interpretations on the strategic issues (Table IV). Spearman's rank ρ was also computed on the industry level to compare the companies' interpretations with the industry-level interpretation, as shown in Table V.

The Spearman's rank correlation shows how the companies, i.e. the boards of directors, interpret strategic issues in relation to each other. If the companies are arranged according to the correlation that the companies are closest to, e.g. company's *B* interpretations, we have the ranking $B \prec C \prec E \prec F \prec G \prec D \prec I \prec A \prec H$. Now, it can be observed that company *B* and *C* have the most similar patterns of issue interpretation among the companies. They perceived the characteristics of the business environment in the same way, leading them to similar cognitive outcomes concerning the sustainability management.

In Table V, the link between the companies' interpretations and the industry-level shared interpretation can be analyzed. According to Spearman's rank correlation, all companies have relatively similar patterns of interpretation on sustainability management issues. When the companies are arranged based on how close their interpretations are to the industry-level shared interpretation, the ranking is $H \prec A \prec C \prec E \prec B \prec F \prec G \prec D \prec I$. Here, it can be seen that company *H* is the closest to industry-level interpretations. In the results gained from the company-wise correlation (Table IV), it can be observed that company *H* has the opposite position. This may indicate that company *H* has the most

Table III Centrality ranking of the strategic issues in the shared cognitive maps of the companies' and the industry by the eigenvector value

ID	Strategic issues in the shared cognitive maps (company-specific issues excluded, ID > 50)	Ranking by centrality Companies A	B	C	D	E	F	G	H	I	Industry
1	Employment contribution in the region (S)		13								
2	Use and development of environmental friendly tech. in products (E)	17		15	11	10		16			18
4	Corruption (S)			14							
5	Sales (Ec)		4	13	6	7	9		6	6	11
6	Shareholder value (Ec)	9	8			1	1		2	1	4
7	Turnover (Ec)	19	10	6			7	5	7	3	7
8	Product/service safety (S)			20	12			14			
9	Public funded projects (EU and National) (S)						17				
11	Energy use of products/services (E)			17		12	13	10			
12	Resource overuse (logistics, services, products) (E)		18	19							
15	Customer satisfaction (Ec)	5	7	4	5	4	8	4	11	8	5
16	Child labor (S)							2			
17	Employee training and education (S)									11	8
18	Equal opportunities and non-discrimination of employees (S)				14			13			
19	Health and safety (employees and citizens) (S)			18	13	13		15			
20	Management quality (labor turnover, work satisfaction) (Ec)	12	16		15			17	19	14	
21	Stakeholder involvement and liaison with NGOs, universities (S)			12	8	17					
23	Wages and benefits of employees (S)									10	
24	Stakeholder involvement and liaison with business partners (Ec)		9						13		16
25	Purchasing operations (Ec)	8	19	11	9				8		14
27	Mission and vision (Ec)	14	20					11		15	
28	Brand, company image (Ec)	1	12	3	4	5	11	9		4	3
29	RandD investments (Ec)			8			18	3			
30	Corporate governance (transparency, following rules/regulation) (S)	10							17	13	
31	Ethical behavior and human rights (S)	2						12			12
34	Long term profitability (Ec)	3	2	1	1	2	3	1	1	2	1
35	Short term profitability (Ec)	11	5	10		14	10		5		10
36	Employees attitude (S)	7				11	19			9	13
37	Growth of the firm (Ec)	6	1	2	3	3	2	2	3		2
38	Competition in the market (Ec)	4	3			8			12		9
39	Prices applied by the Firm (Ec)			7		15	14		10	7	
40	Customer relations (Ec)	13			7	6	15	7	4	5	6
41	Legal/regulative expertise in sustainability (E)			16	10						
42	Technological expertise in renewables (E)	18					16				
43	Leadership within the organization (S)				16	18		6			
45	International business growth (Ec)		11		2		12	8	9		8
47	Relations with suppliers (Ec)			9				19	18		20
48	Knowledge of needs of market (domestic) (Ec)					16					
50	Sustainability strategy (Ec)		14			9	5	20	16		15

Table IV Spearman's rank correlation coefficient for the ranked central strategic issues between the companies

Company	A	B	C	D	E	F	G	H	I
A	1	0.863452	0.861912	0.872578	0.900252	0.870703	0.859225	0.807741	0.875588
B	0.863452	1	0.908553	0.892483	0.900014	0.897214	0.894751	0.85175	0.887906
C	0.861912	0.908553	1	0.965747	0.917049	0.91313	0.949006	0.841237	0.891167
D	0.872578	0.892483	0.965747	1	0.939964	0.905319	0.955375	0.838858	0.920437
E	0.900252	0.900014	0.917049	0.939964	1	0.929087	0.92787	0.850798	0.926162
F	0.870703	0.897214	0.91313	0.905319	0.929087	1	0.905431	0.825826	0.890244
G	0.859225	0.894751	0.949006	0.955375	0.92787	0.905431	1	0.831859	0.902632
H	0.807741	0.85175	0.841237	0.838858	0.850798	0.825826	0.831859	1	0.8521
I	0.875588	0.887906	0.891167	0.920437	0.926162	0.890244	0.902632	0.8521	1

diverse interpretation that covers a wide range of sustainability issues on its cognitive map, and, in this way, it is closest to the industry average.

Finally, the relationship between the cognitive diversity and the strategic issue interpretation among the companies can be analyzed. In Table II, the correlation between

Table V Spearman's rank correlation coefficient for the ranked central strategic issues between the companies and the industry

	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*
Industry	0.903135	0.881523	0.888396	0.862486	0.882685	0.881397	0.871179	0.907811	0.841601

the company rankings computed from the industry-level cognitive diversity ratios (Table II) and the Spearman's rank correlation of strategic issue interpretations (Table V) is shown.

In Table VI, a significant correlation (0.762) between the rankings can be observed. For example, the distance ratio of companies *A* and *C* are the closest to the industry-level shared cognitive map, and their Spearman's rank correlations are the second and third closest to the industry-level interpretation. This indicates that the cognitive diversity of the boards of directors has an impact on the strategic issue interpretation, providing similarities (or differences) in the cognitive maps among the companies operating within the same industry.

4. Discussion and conclusion

Representing the social–cognitive approach on corporate governance research, this exploratory study examined the relationship between cognitive diversity and strategic issue interpretation through individuals' beliefs, values and normative differences within the boards of directors. The initial industry sample was constructed to find out the influence of cognitive diversity on the companies' interpretations by selecting companies in different business sectors within the same industry.

First, the hybrid causal mapping technique was applied for direct access to identify the boards of directors' strategic sense-making process by utilizing the board members' cognitive maps as constructs of interpretation of the business environment, which was sustainability management for this study. According to the results, the distance ratios show that the companies have a significant diversity between their cognitive maps. This indicates that the boards act as information filters/sense-making bodies with different cognitive frames providing different interpretations (Hambrick and Mason, 1984; Grandori, 1997; von Krogh *et al.*, 2000). For example, companies *B* and *I*, which operate in different sectors, are the most distant companies and may have the potential to have the most different cognitive outcomes. When analyzing industry-level distance ratios, they indicated overlapping on cognitive maps among the company boards, e.g. boards of companies *C* and *A* are equidistant from the industry average, having the potential for similar interpretative patterns; however, Markoczy and Goldberg (1995) have claimed that the distance measure shows differences between the cognitive maps but explains less about differences in the relationship between the issues interpreted by the respondents, which were here the members of the boards.

Table VI Correlation between the ranking of the industry-level cognition and interpretation

	RankDiv	*RankIss*
Spearman's RHO		
RankDiv		
Correlation coefficient	1	0.762*
Significance (two-tailed)		0.017
N	9	9
RankIss		
Correlation Coefficient	0.762*	1
Significance (two-tailed)	0.017	
N	9	9

Note: *Correlation is significant at the 0.05 level (two-tailed)

When analyzing the strategic issue interpretation on sustainability management by the boards, it was first noticed that the economic issues dominated their attention. The frequency rate of the economic issues was significantly higher than the environmental and social category issues, showing that the existing cognitive frames of the board members may exclude the sustainability management issues in the strategic landscape (Hambrick and Mason, 1984; Ocasio, 1997, 2011). This may indicate the minor value of the sustainability management issues for the companies or the board members who may have limited experiences in sustainability management issues and underestimate the relevancy of the issues (Dutton and Duncan, 1987). The high frequency rate in the cognitive maps does not necessarily predict the influential role of the issue in the cognitive maps. To be claimed relevant, the stimuli must meet directors' existing cognitive repertoire and be in the frames of the shared cognitions of the company (Dutton and Duncan, 1987; Lyles and Schwenk, 1992; von Krogh *et al.*, 2000).

Therefore, the causal network analysis was conducted next using the eigenvector centrality measure to examine the causalities between the issues in the shared cognitive maps. The higher the eigenvector value, the more influential the issue is in a cognitive map. Despite the research setting and the topicality of the sustainability management in business and research, our study provides results that could be considered unexpected. According to our results, the economic category issues achieved the most central role, and the sustainability issues had only a minor or no role in boards' shared cognitive maps; however, previous research on corporate sustainability has indicated that environmental and social issues often influence both the costs and income of a company, posing a direct influence on the economic success of the company (King and Lenox, 2001; Schaltegger and Synnestvedt, 2002; Eweje, 2011). In this case, our results support this evidence, and corporate sustainability represents not the goal but the means of achieving more traditional corporate objectives, which are at the centre of top decision-makers' attention. The alternative explanation is related to the nature of the board as representatives of shareholders rather than a wide range of stakeholders. It can be assumed that the views of the stakeholders would be more closely associated with the sustainability agenda (Steurer *et al.*, 2005; Minyu, 2011).

Regarding the similarities of the interpretative patterns, Spearman's rank ρ showed strong correlations between the companies' interpretations on the strategic issues on both the company and the industry level. Comparing Spearman's rank ρ with cognitive diversity ratios, it could be seen that the lower distance ratio between the company's shared cognitive map and the industry-level shared cognitive map, the higher Spearman's rank ρ is. For example, companies *A* and *C* have low distance ratios, showing a closeness to the industry average, and a high Spearman's rank ρ, showing strong similarities in issue interpretation among the boards of different companies.

Finally, our results identify the relationship between the decision-making groups' shared cognitive frames and strategic interpretation and are in line with previous studies (Hambrick and Mason, 1984; Forbes and Milliken, 1999; von Krogh *et al.*, 2000; van Ees *et al.*, 2009; Sur, 2014). The results provide evidence for the assumption that a low degree of cognitive diversity within decision-making groups indicates the similarities of strategic issue interpretations among the companies (Markoczy, 2001; Sur, 2014).

As a whole, our study contributes to behavioral research on corporate governance (van Ees *et al.*, 2009) by investigating the role of cognitive diversity on the strategic issue interpretation of the boards on two levels of analysis: company and industry. We also provide empirical support on the reliability of the statistical analysis of cognitive maps by combining the distance ratio and eigenvector value (Langfield-Smith and Wirth, 1992; Markoczy and Goldberg, 1995; Nicolini, 1999; Hodgkinson *et al.*, 2004). In addition, our study contributes to the literature by indicating the current minor role of sustainability management issues in top decision-makers' cognitive frames and their strategic landscape.

However, it is appropriate to note the inherent limitations of the study. The initial industry sample provides relatively restricted perspectives on the cognition of the board members, and to conform the reliability of the findings regarding the effects of the industry on shared cognitive structures, a larger collection of data needs to be examined. The study could be applied to larger firms, especially outside the cleantech industries. For instance, Barrow (2001) found that the role of non-executive directors in high-tech SMEs is different than the role they play in larger companies. We can expect that factors such as this will substantially affect the cognitive frames and patterns of the interpretation of the strategic issues. The results could have been influenced by the peculiarities of the board decision process when sessions are organized infrequently and cover an extensive amount of business information in a limited timeframe, so they operate under attention-based constraints (Ocasio, 1997; Sur, 2014). Despite the limitations, our study increases understanding on the complex relationship between shared cognition and strategic issue interpretation within top-level decision-making groups.

Consequently, the complexity of the unit of analysis, the need for multidisciplinarity, the data requirements and the high costs of collecting information create difficult, if not impossible, hypotheses testing as a further research avenue. Under these limitations, prospective research could be based on a multiple case study approach (Yin, 2003). The first motive thereto was the complexity of the board as a unit of analysis. The strategic issues' interpretations within the board are complex phenomena that are difficult to isolate from their contextual environment. Factors such as individual considerations, the institutional affiliations of directors and market influences have a considerable impact on these interpretations. Hence, a profound qualitative data collection and a multidisciplinary analysis are necessary to grasp the phenomena as they appear in reality; however, this paper provides a point of reference for practitioners and for further research efforts.

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Appendix 1

Table AI The final pool of constructs of strategic issues on 'sustainability management'

ID.	*Firm's strategic sustainability issues*
1	Employment contribution in the region (S)
2	Use and development of environmentally friendly technologies in products (E)
3	Freedom of association (labour unions etc.) (S)
4	Corruption (S)
5	Sales (Ec)
6	Shareholder value (Ec)
7	Turnover (Ec)
8	Product/service safety (S)
9	Public funded projects (EU and National) (S)
10	Biodiversity in all activities of the firm (E)
11	Energy use of products/services (E)
12	Resource overuse (logistics, services, products) (E)
13	Transport/logistic of products/services (E)
14	Water use and emissions of products/services (E)
15	Customer satisfaction (Ec)
16	Child labour (S)
17	Employee training and education (S)
18	Equal opportunities and non-discrimination of employees (S)
19	Health and safety (employees and citizens) (S)
20	Management quality (labour turnover, work satisfaction) (Ec)
21	Stakeholder involvement and liaison with NGOs, universities (S)
22	Social partnership and sponsorship (S)
23	Wages and benefits of employees (S)
24	Stakeholder involvement and liaison with business partners (Ec)
25	Purchasing operations (Ec)
26	Sustainability reporting (E)
27	Mission and vision (Ec)
28	Brand, company image (Ec)
29	R & D investments (Ec)
30	Corporate governance (e.g. transparency, following rules/regulation) (S)
31	Ethical behaviour and human rights (S)
32	Corporate citizenship and charity work (S)
33	Lobbying (direct and indirect) (Ec)
34	Long term profitability (Ec)
35	Short term profitability (Ec)
36	Employees attitude (S)
37	Growth of the firm (Ec)
38	Competition in the market (Ec)
39	Prices applied by the Firm (Ec)
40	Customer relations (Ec)
41	Legal/regulative expertise in sustainability (E)
42	Technological expertise in renewables (E)
43	Leadership within the organization (S)
44	Investments in marketing (Ec)
45	International business growth (Ec)
46	Bank connections (Ec)
47	Relations with suppliers (Ec)
48	Knowledge of needs of market (domestic) (Ec)
49	Knowledge of needs of market (international) (Ec)
50	Sustainability strategy (Ec)
51	*Open for additional topic of the respondent*
52	*Open for additional topic of the respondent*

Notes: **S**ocial, **EC**onomic, and **E**nvironmental issue categories were excluded from the list of the respondents

Appendix 2

Figure AI Diagrammatic presentations of cognitive maps of the board members of company F

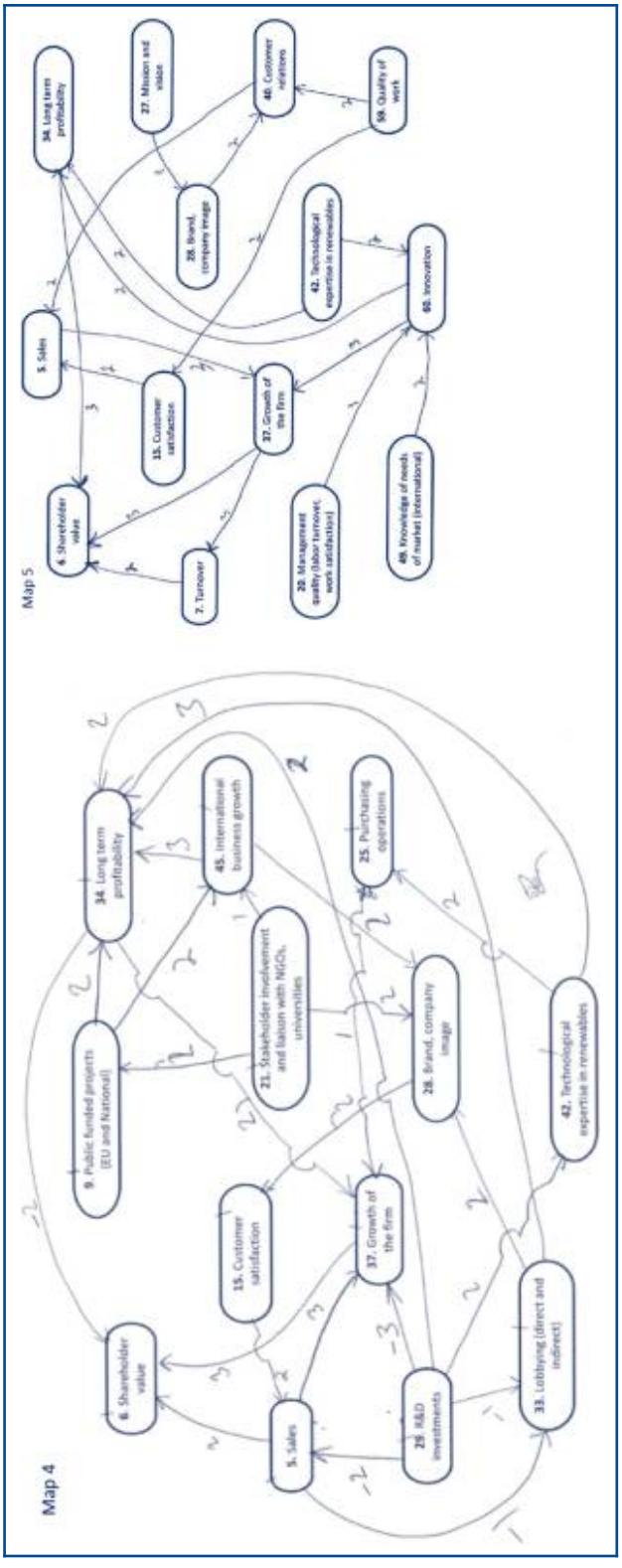


Table AII An association matrix (13x13) of a member 4 of the BOD in company F

	5	6	9	15	21	25	28	29	33	34	37	42	45
5	0	2	0	0	0	0	0	0	−1	0	3	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	2	0	0	2
15	2	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	2	0	0	0	2	0	0	0	0	0	1
25	0	0	0	0	0	0	0	0	0	0	1	0	0
28	0	0	0	2	0	0	0	0	0	0	0	0	0
29	−2	0	0	0	0	0	0	0	−1	2	−3	2	0
33	0	0	0	0	0	0	2	0	0	3	0	0	0
34	0	−2	0	0	0	0	0	0	0	0	2	0	0
37	0	3	0	0	0	0	0	0	0	0	0	0	0
42	0	0	0	0	0	2	0	0	0	2	0	0	0
45	0	0	0	0	0	0	2	0	0	3	0	0	0

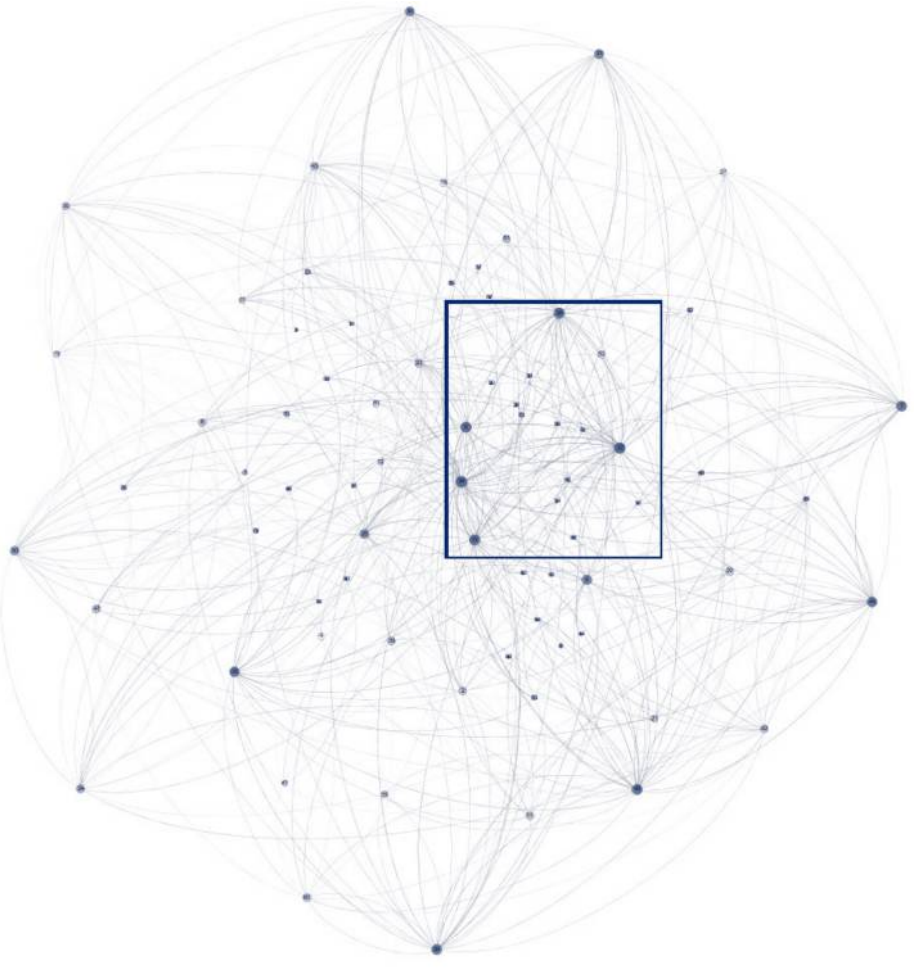
Appendix 3

Table AIII Extended association matrix 100 × 100, e.g. shared cognitive map of company G

	2	5	6	7	8	9	11	15	18	19	20	21	23	25	27	...	...	98	99	100
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0
5	0	0	0	0	0	0	0	0	0	0.5	0	0.5	0	0	0			0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	−0.25	0	0	0			0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0			0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0
21	0	0	0	0	0	0	0.75	0	0	0	0	0	0	0	0			0	0	0
23	0	0	0	0	0	0	0.5	0.5	0	0	0	2.25	0	0	0.75			0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0
27	0	0	0	0	0	0	0	0.75	0	0	0	0	0	0	0			0	0	0
...																		0	0	0
																		0	0	0
...																		0	0	0
98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 4

Figure AII The centrality of the strategic issues in the shared cognitive map of the industry



Notes: Red color and large size demonstrate very central role, blue color and small size demonstrate minor role

Table AIV Eigenvalues for the strategic issues (Top 20) in the shared cognitive maps

	A		*B*		*C*		*D*		*E*		*F*		*G*		*H*		*I*		*Industry*	
Rank	*Issue*	*Eigen*	*Issue*	*Eigen*	*Issue*	*Eigen*	*Issue*	*Eigen*	*Issue*	*Eigen*	*Issue*	*Eigen*	*Issue*	*Eigen*	*Issue*	*Eigen*	*Issue*	*Eigen*	*Issue*	*Eigen*
1	28	1.000	37	1.000	34	1.000	34	1.000	6	1.000	6	1.000	34	1.000	34	1.000	6	1.000	34	1.000
2	31	0.796	34	0.458	37	0.934	45	0.513	34	0.885	37	0.663	37	0.624	6	0.935	34	0.883	37	0.974
3	34	0.757	38	0.298	28	0.741	37	0.453	37	0.623	34	0.614	29	0.404	37	0.698	7	0.707	28	0.727
4	38	0.717	5	0.290	15	0.687	28	0.452	15	0.533	51	0.462	15	0.399	40	0.342	28	0.582	6	0.697
5	15	0.672	35	0.257	45	0.473	15	0.428	28	0.521	50	0.349	7	0.345	35	0.327	40	0.517	15	0.670
6	37	0.622	52	0.207	7	0.374	5	0.402	40	0.361	55	0.167	43	0.315	5	0.292	5	0.463	40	0.646
7	36	0.502	15	0.190	40	0.293	40	0.363	5	0.300	7	0.156	40	0.311	7	0.248	39	0.253	7	0.569
8	25	0.485	6	0.150	29	0.260	21	0.205	38	0.091	15	0.124	45	0.303	25	0.226	15	0.211	45	0.550
9	6	0.468	24	0.101	47	0.253	25	0.101	50	0.039	5	0.115	28	0.301	45	0.208	36	0.083	38	0.550
10	30	0.361	7	0.092	35	0.211	41	0.087	2	0.037	35	0.115	11	0.224	39	0.182	23	0.062	35	0.538
11	35	0.348	45	0.088	25	0.209	2	0.038	36	0.036	28	0.105	27	0.219	15	0.168	17	0.025	5	0.471
12	20	0.340	28	0.074	21	0.188	8	0.038	11	0.030	45	0.042	31	0.165	38	0.136	73	0.010	31	0.408
13	40	0.312	1	0.063	5	0.187	19	0.030	19	0.024	11	0.025	18	0.146	24	0.114	30	0.008	36	0.387
14	27	0.301	50	0.049	4	0.101	18	0.009	35	0.016	39	0.025	8	0.144	81	0.097	20	0.004	25	0.364
15	59	0.280	51	0.049	2	0.068	20	0.004	39	0.011	40	0.017	19	0.128	76	0.094	27	0.004	50	0.301
16	60	0.280	20	0.037	41	0.046	43	0.004	48	0.011	42	0.017	2	0.119	50	0.087	1	0.000	24	0.250
17	2	0.262	73	0.027	11	0.042	1	0.000	21	0.004	9	0.005	20	0.102	30	0.070	2	0.000	8	0.209
18	42	0.255	12	0.027	19	0.040	3	0.000	43	0.004	29	0.005	17	0.098	47	0.052	3	0.000	2	0.201
19	7	0.200	25	0.027	12	0.033	4	0.000	1	0.000	36	0.005	47	0.095	20	0.046	4	0.000	51	0.201
20	52	0.160	27	0.027	8	0.028	6	0.000	3	0.000	53	0.005	50	0.095	78	0.029	8	0.000	47	0.200