Jukka-Pekka Bergman

MANAGERIAL COGNITIVE STRUCTURES, STRATEGY FRAMES, COLLECTIVE STRATEGY FRAME AND THEIR IMPLICATIONS FOR THE FIRMS

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Abstract

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The overall aim of this doctoral dissertation is to increase the understanding of the interconnection between the top managers, the firms, and the industry by investigating the managerial cognitive structures and their organisational implications in different levels of analysis. The roots of this research can be found in the schema theory and the cognitive construction view of the industry. In its studies, this dissertation uses both quantitative and qualitative methods, following the mixed methods research design along the lines of the reality-based assumptions about critical realism. First, the study operationalises the concept of dominant logic with quantitative data by revealing the combined effect of dominant logic and the firm's strategic activities on the firm performance. By analysing dominant logic as a cognitive structure, the study uses cognitive maps collected from the top and middle managers, showing differences in cognitive diversity between these two management levels. Next, the study investigates the firms' decision-makers' cognitive structures, showing the relationships between cognitive diversity and firm-level interpretations as well as cognitive diversity and demographic backgrounds. For this purpose, the cognitive mapping method with quantitative measures, distance ratio and eigenvalue of centrality were used. Finally, the study investigates the development of the collective strategy frames within the cleantech industry. Through the analysis of the cleantech firms' annual reports over eight years, the study reveals common cognitive patterns among the firms, demonstrating the development of the collective strategy frame.

An important contribution of the dissertation relates to the research methodology. This dissertation advances the managerial cognition research methodology, using direct cognitive measures for the elicitation and analysis of cognitive maps for different levels of analysis. The doctoral dissertation also provides insights into the emergence of the cleantech industry as a collective social phenomenon and brings forth studies on industry and market boundaries. In summary, the doctoral dissertation contributes to the strategic management literature in the field of managerial cognition, especially strategy frame research.

Keywords: cognitive structure, strategy frame, cognitive mapping, distance ratio, top management

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My family, you have always been encouraging me saying “you can do whatever you want to”. Thank you for everything. *Verna* you are always in my mind.

Jukka-Pekka Bergman

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I will always love you…

Verna

Contents

List of Publications

This dissertation is based on the following papers. The rights have been granted by the publishers for the papers to be included in the dissertation.

I. Bergman, J-P., Jantunen, A., and Tarkiainen, A. (2015). Managerial cognition and dominant logic in innovation management: Empirical study in media industry. *International Journal of Business and Innovation Research*, 9(3), pp. 253-271.

II. Bergman, J-P., Platonov, V., Dukeov, I., Röyttä, P., and Luukka, P. (2016). Information processing approach in organisational cognitive structures: Relationship between top and middle managers' cognitions. *International Journal of Information Systems and Social Change.* 7(4), pp. 1-19.

III. Bergman, J-P., Knutas, A., Luukka, A., Jantunen, A., Karlik, A., and Platonov, V. (2016). Strategic interpretation on sustainability issues—eliciting cognitive maps of boards of directors. *Corporate Governance: The International Journal of Business in Society*, 16(1), pp. 162-186.

IV. Bergman, J-P., Luukka, P., Jantunen, A., and Tarkiainen, A. (2020). Cognitive diversity, managerial characteristics and performance differences across the cleantech firms. *International Journal of Knowledge Based Organizations*, 10(1), pp. 1-26.

V. Bergman, J-P., Hajikhani, A., and Blomqvist, K-M. (2019) Emergence and development of the cleantech industry: A cognitive construction approach. *Journal of Cleaner Production*, 233, pp. 1170-1181.

Author's contribution

I am the principal author and the investigator in publications I – V:

In Publication I: responsible for the research idea, the theoretical framework, and the conclusions of the study. The data was analysed and the results were interpreted in cooperation with the co-authors.

In publications II – V: responsible for the research idea, the data collection, the theoretical framework, and the conclusions of the study. The data was analysed and the results were interpreted and presented in cooperation with the co-authors.

Nomenclature

A	area of the map
A_{ij}	matrix A
aij	value of the ith row jth column in the matrix
DR	distance ratio
IT	information technology
ICT	information and communication technology
IoT	internet of things
LSW	Langfield-Smith & Wirth
NA	set of nodes in Map A
NB	set of nodes in Map B
OLS	ordinary least squares
P	total number of possible nodes
Pc	set of nodes common to both maps
pc	number of total nodes
puA	number of nodes unique to Map A
puB	number of nodes unique to Map B
SME	small and medium size enterprise
χ_n	vector of centralities (gamma)
λ	constant (lambda)
λx	eigenvector of the association matrix with eigenvalue
$\alpha, \beta, \gamma, \delta, \varepsilon$	parameters in the equations (alpha, beta, gamma, delta, epsilon)
ρ	Spearman's ranking correlation coefficient (rho)

1 Introduction

Changing industry conditions have been a topic of great interest among researchers and practitioners in strategic management (Tushman & Anderson, 1986; Eisenhardt, 1989b; Tripsas & Gavetti, 2000; Kaplan, 2011). However, industry change is not an immediate event but rather a process that may take years, emerging either quickly and completely or slowly and incompletely, hence difficult to recognise and envision (Wessel & Christensen, 2012). Often fast-changing industries are characterised by rapid changes in their products and process technologies, and firms' competitiveness is limited by their ability for strategic awareness (Anderson & Tushman, 1990; Karim et al., 2016). In contrast, stable industries may provide relatively predictive business environments for their operations and gain sustainable competitive advantages by continuously developing firms' competencies and operations (Brown & Eisenhardt, 1997; Eggers & Kaplan, 2009). Several studies have claimed that the industry conditions reflect firms' beliefs of the competitive environment, shared among their business networks as a primary factor for collective action, which, in turn, drive industry change (Porac et al., 1989; Bogner & Barr, 2000; Cattani et al., 2017). This explanation of the construction of the industry conditions contends that firms actively interpret and shape their business environments through their cognitive activities rather than exclusively response to them.

Managerial cognition research originates in Simon's work on the behavioural model of rational choice in the early 1950s and subsequent works by Simon and March, and Cyert and March in the 1960s on behavioural theory of the firm. This line of research is also known as cognitive school and Carnegie school of strategy. Research in managerial cognition has provided compelling results for firms' responses to their environments, especially prior research has stressed the importance of top managers' shared cognitive structure that serves as a general strategy frame through which managers interpret information from their environment to reduce complexities in it and then translate the attained perspectives into strategic choices (Hambrick & Mason, 1984; Prahalad & Bettis, 1986; Porac et al., 1989; Barr, 1998; Laukkanen, 1998; Eggers & Kaplan, 2009). The studies in managerial cognition taking social cognition approach have addressed the significance of cognitive differences among a specific network of actors in organisational responses to the industry conditions (Bogner & Barr, 2000; Nadkarni & Narayanan, 2007b; Hodgkinson, 2015; Kiss & Barr, 2015; Cattani et al., 2017). Recently, some studies applying the cognitive construction view of industries have highlighted the central role of collective strategy frames in the relationship between the industry development and firms' actions (Bogner & Barr, 2000; Nadkarni & Narayanan, 2007a; Cattani et al., 2017). The studies on managerial cognition taking social cognition approach propose that firms not only respond differently to changing industry conditions due to different perceived reality but also construct a collective strategy frame that drives firms towards aggregated actions and, in turn, drive industry development. Nevertheless, research into the complex links between managers' cognitive structures, strategy frames, firms actions, and industry characteristics calls for more comprehensive studies, although the investigation into organisational cognitive structures has been an important theme in the

strategic management literature (Kaplan, 2011; Narayanan et al., 2011; Hodgkinson, 2015, Laukkanen, 2018).

As economy is transforming towards more sustainable and information-intensive services and goods (Child & McGrahath, 2001; Davies, 2013; Meristö & Laitinen, 2017), firms' abilities to interpret myriad signals from the environment and translate them into strategic actions are closely tied to shared cognitive structures (i.e. strategy frames developed by firms' top managers) (Nadkarni & Narayanan, 2007b; Hahn et al., 2014; Martignoni et al., 2016). Consequently, more attention should be paid to the links between managers and firms and firms and the industry with a view to identifying the differences between the firm-level strategy frames and individual managers' interpretations of environmental changes and, in turn, explaining organisations' choices (Nadkarni & Barr, 2008; Kiss & Barr, 2015; Planko et al., 2016). As strategy frames are developed in the interaction between individuals within a firm operating in a particular industry, strategy frames hold both the knowledge and beliefs shared among the top management of the firm and the beliefs shared across the member firms of the industry. Because firms' strategy frames reflect their managers' assumptions about how competition functions, critical for firms' success are distinctive characteristics of their strategy frames which determine the information that managers identify and consider the most relevant to their firms. Thus, firms' responses to environmental conditions are tightly connected to their strategy frames (Nadkarni & Narayanan, 2007b; Hahn et al., 2014; Gavetti & Warglien, 2015). Such different characteristics of strategy frames among the firms arise from the content that consists of cognitive elements that managers assume and believe as well as the structure that refers to causal relations between these elements in strategy frames (Nadkarni & Narayanan, 2007b; Hahn et al., 2014). For example, the new ventures having complex strategy frames pursue a more diverse set of actions concerning the business environment compared to the ventures with focused frames (Kiss & Barr, 2015). Accordingly, the content and structure of strategy frames determine how managers interpret the ongoing events in their environment, envision the development of the environment, and develop alternative options for future strategies (von Krogh et al., 2000; Hodgkinson et al., 2009). Because of the importance of strategy frames explaining managers' interpretations, firms' choices and industry conditions, recent research has increasingly emphasised the need for integrative studies with multiple methods for a better understanding of the complex dynamics of managers' cognitive structures, strategy frames and industry conditions (Porac & Thomas, 2002; Powell et al., 2011; Hodgkinson, 2015).

Recently, strategic management research in cognitive structures in different organisational settings has stressed the need for comprehensive studies to tackle the aggregation problem of cognition (Powell et al., 2011; Narayanan et al., 2011). This study investigates the firms operating in cleantech and media industries, facing disruption of their competitive boundaries by the fast development of technologies and emergence of new actors (Arsenault & Castells, 2008; Davies, 2013). Thus, this study aims to intrude into the complex phenomenon of managerial cognition at different levels of analysis to develop a methodology for the analysis of cognitive structures for operationalising the

concept of strategy frame at multiple levels of analysis; it also aims to develop mathematical measures to obtain more information embedded in managers' cognitive structures (Laukkanen, 1990; Langfield-Smith & Wirth, 1992; von Krogh et al., 2000; Markoczy, 2001; Nadkarni & Narayanan, 2007b). Through this understanding, this thesis contributes to the strategic management literature in the field of managerial cognition, especially strategy frame research (Porac & Thomas, 2002; Kaplan, 2011; Narayanan et al., 2011; Cattani et al., 2017).

Thus, previous managerial cognition research in strategic management cited top managers' cognitive structures as a key explanation for firms' behaviour and construction of industries. This thesis utilises these studies and their understandings in its research.

1.1 Key concepts

Cognitive structure

The way managers make causal explanations and act in their environments is connected to cognitive structures developed in organisational contexts (Walsh, 1995). These structures are bundles of cognitive cause-effect images that are developed through experience and stored in the memory as higher-level abstractions of interconnecting events (Abelson, 1981). They allow individuals to cope with and have expectations of others' behaviour to respond to forthcoming situations (Abelson, 1981; Gentner et al., 1993). The cognitive structure is a 'mental template that individuals impose on an information environment to give it form and meaning' (Walsh, 1995: 281). In other words, it is a representation of organised knowledge of causal relations of a particular knowledge environment, enabling managers to make sense of and enact that environment (Tyler & Gnyawali, 2009).

In strategic management, managerial cognition research assumes that cognitive structures play a central role in managers' actions (Hodgkinson, 2015). As human rationality is bounded by (physical and) mental abilities, managers cannot create a comprehensive understanding of the environment where cognitive structures enable them to 'develop subjective representations of the environment that, in turn, drive their strategic decisions and subsequent firm action' (Nadkarni & Barr, 2008: 1395). Cognitive structures are also unique to managers and are composed of two dimensions of complexity: 'content consists of information he/she assumes, knows, believes, and structure refers to how the content is organized in managers' minds' (Finkelstein & Hambrick, 1990: 57). The attributes of complexity in terms of content and structure define a manager's ability in 'differentiation—the ability to perceive several dimensions in a stimulus array—and integration—the development of complex connections among differentiated characteristics' (Kolb & Bartunek, 1992: 274). The subjectivity of cognitive structures may also lead to the misinterpretation of a situation and overconfidence of the existing knowledge embedded in the structures (Martignoni et al., 2016). Hence, cognitive structures developed over time through experience enable and constrain managers' interpretations and choices concerning their environment.

Dominant logic

Prahalad and Bettis (1986) introduced the concept of dominant logic which refers to the way firm's managers 'conceptualize the business and make critical resource allocation decisions—be it in technologies, product development, distribution, advertising, or in human resource management' (Prahalad & Bettis, 1986: 490). Dominant logic of the firm provides legitimacy and guidance for their members' decisions and actions; however, it may also cause incapability and inertia to perform in changing environments (Bettis & Prahalad, 1996; von Krogh et al., 2000; Nadkarni & Narayanan, 2007; Maijanen-Kyläheiko, 2014). Recent managerial cognition literature has shown that dominant logic of the firm as an information filter becomes apparent in management practices and processes that firms pursue when creating and implementing strategies; concerning its relationship with firms' performance, dominant logic drives the organisation towards selective consideration of all 'available' information around it (Prahalad & Bettis, 1986; Johnson & Hoopes, 2003; Nadkarni & Narayanan, 2007b). Once a firm has formed shared assumptions about business, organisation and environment, it begins to build its routines and practices around these assumptions and over time form the dominant logic of the firm. Dominant logic creates an opportunity to direct the limited resources and attention to the events that are vital to the organisation, although it also restricts recognising the potential opportunities (Prahalad & Bettis, 1986; Johnson & Hoopes, 2003; von Krogh et al., 2000). Further, von Krogh et al. (2000) suggest that dominant logic represents a commonly understood, accepted and disseminated repertoire of cognitive maps making it possible to filter information, make sense of it and envision the future development. On the whole, firms' dominant logic has a strong influence on how top managers, as key informants of the organisation, make sense of their environment and the decisions they make. Thus, dominant logic of the firm impacts on organisational behaviour and influences performance (Prahalad Bettis, 1995; von Krogh et al., 2000; Maijanen-Kyläheiko, 2014).

Strategy frame

Organisations are fundamentally considered cognitive systems of learning and knowledge development (Argyris & Schon, 1978). As a cognitive act is a social endeavour, cognitions are always situated and influenced by other people (Levine et al., 1993). Consequently, by interacting with each other in a particular social group (e.g. top management team), team members develop a shared cognitive 'product' (cognitive frame or structure) embedded in commonly accepted values, norms and beliefs of the environment that influences individuals' interpretations and responses to information they receive (Levine et al., 1993). These shared cognitive structures differ from individuals' cognitive structures being socially constructed and commonly accepted within that organisational context (Daft & Weick, 1984).

In organisations, many people may contribute to organisational sensemaking process; however, top managers play a pivotal role in defining the strategies and allocating critical resources (Hambrick & Mason, 1984); top managers are also assumed to select and synthesise the most relevant information for the organisation as a whole (Prahalad & Bettis, 1986; Lyles & Schwenk, 1992). Thus, managers' shared cognitive structure, known as the strategy frame, reflects top managers' strategic thinking (Nadkarni & Narayanan, 2007b). Strategy frames act as cognitive lenses through which top managers interpret the information and translate it into strategic choices (Prahalad & Bettis, 1986; Schraven et al., 2015). Strategy frames shape top managers' conceptualisation of the environment; they focus managers' attention on information that is embedded in the core of the frames (Nadkarni & Narayanan, 2007b). The strategy frame research also theorises dominant logic as a mental construct of the top management, which needs to be measured as a shared cognitive structure (Narayanan et al., 2011). Having an explicit cognitive structure, strategy frame has a unique presence at different levels of the organisation (Nadkarni et al., 2011; Schraven et al., 2015).

As strategy frames are originally individual-level constructs, differences between the strategy frames occur in their characteristics. Strategy frames hold commonly shared concepts that are ordered in a particular form around the core concepts essential for the organisation (Nadkarni & Barr, 2008). Depending on the organisation's history, strategy frames have different content and structure and, consequently, lead organisations towards different choices and strategies concerning the events they face in their businesses. Thus, the strategy frame is a shared cognitive structure developed by top managers which stores the understanding of a firm's businesses, organisation and environment, enabling top managers to scan, interpret information and make strategic choices regarding the competitive environment.

Collective strategy frame

Managerial cognition research taking the cognitive construction view draws on social movement research, especially social constructivism which originates in Berger & Luckmann (1967) concept of the shared phenomenon of socially constructed reality. From this perspective, the social context (e.g. an industry) is collectively constructed based on shared conceptualisations of industry boundaries, memberships and competitive advantage (Huff, 1982; Tsoukas, 1996). The cognitive construction view of industry assumes that the members of the industry share and develop their beliefs and knowledge through interaction and that this social interaction creates similarity in their beliefs and actions and over time becomes social facts of collectively constructed norms, rules and values defining the competitive boundaries of the industry (Porac et al., 1989; Barley & Tolbert, 1997; Cattani et al., 2017). These industry-level collective strategy frames subsequently converge organisations' actions, lead organisational similarities and over time shape the character of the industry (Bogner & Barr, 2000; Nadkarni & Narayanan, 2007a).

Thus, a collective strategy frame is a product of the social interaction among a group of industry members (Nadkarni & Narayanan, 2007a; Cattani et al., 2017). Collective strategy frames hold both the commonly shared understandings of the industry and the organisation-specific knowledge of the competitive environment, which are available to the group of organisations of that particular industry (Huff, 1982; Tsoukas, 1996). Variety in organisations' actions arises from their different social networks; for example, manufacturing versus energy production sector firms within the cleantech industry provide different cognitive repertoire between the industry members, meaning that organisations perceive the common concepts embedded in the collective cognitive frames differently, generate variety in their actions and, in turn, drive industry development (Nadkarni & Narayanan, 2007a; Cattani et al., 2017). Hence, collective strategy frames tie organisations together as representatives of the industry, allowing them to identify and interpret information and events through the shared repertoire of distinctive interconnected concepts for different strategic use by the members of the industry.

Top management

In managerial cognition literature, top managers, often an organisation's executive directors, have been considered key intermediaries between organisations' internal and external environments, facing the challenge of making complicated choices under uncertainty and bounded information (Hambrick & Mason, 1984; Hodgkinson, 2001; Eggers & Kaplan, 2009; Bromiley & Rau, 2016). Top managers are key decision-makers who scan and interpret information for the organisation as a whole (Huff, 1982). Despite top managers' key decision-making role, boards always have the power to ratify top-level managers' strategic decisions (Fama & Jensen, 1983) and provide ongoing advice and operative frames to top managers on strategic changes (Carpenter & Westphal, 2001). Initially, only executives who also serve on the board of directors were identified as top management team members (cf. Finkelstein & Hambrick, 1990; Daily & Schwenk, 1996). The key decision-makers selected to develop and drive organisations' strategy establish top-level management that comprises 'a collection of key individuals (i.e. a dominant coalition) who have a significant influence on the way the organization is managed' (Prahalad & Bettis, 1986): 490). Nevertheless, a large number of organisations' members may take part in organisational sensemaking processes. Central to managerial cognition research is that at the top management level, information is assumed to be synthesised and interpreted for strategic decision-making in allocating the organisation's critical resources (Daft & Weick, 1984; Lyles & Schwenk, 1992; Hodgkinson & Healey, 2008; Nadkarni & Barr, 2008).

1.2 Research gap, objectives and research questions

During the past decade, demand has increased for a truly comprehensive understanding of social cognitive dynamics of industry competition and change, which transcends the traditional industrial organisation and organisational theories, considering the role of generative mechanism within and across multiple levels of analysis—from the individual to the organisational, inter-organisational and (inter-) industry levels (Gavetti & Rivkin,

2007; Narayanan et al., 2011; Hodgkinson, 2015; Cattani et al., 2017). An important assumption emerged from the managerial cognition research, especially the strategy frame studies involved in the connection between competitive environment and individual firm strategic behaviour; they argued that the link between industry- and firm-level dynamics is the 'shared mental structure' of a firm's decision-makers (Narayanan et al., 2011; Kaplan, 2011). Although considerable attention has been paid to studying managerial cognitive structures within organisations, the 'burden evidence' is still required to explain their appearance and dominance within and across organisations (Narayanan et al., 2011; Hodgkinson, 2015; Schraven et al., 2015). The field of managerial cognitive structures, especially strategy frame research that includes conceptual unity, assumptions and boundaries at the organisation and industry levels, can be updated and extended to yield a comprehensive understanding of the strategy and industry dynamics research.

Besides the theoretical demand for a comprehensive understanding of social cognitive dynamics of the industry, the field of the strategy frame research has several gaps. The studies that have investigated the problem of collective cognition across organisations are yet to show the precise extent to which collective cognition exists, even in established industries; they are also expected to show how the construct of collective cognition should be conceptualised and measured at different levels of analysis (Narayanan et al., 2011; Hodgkinson, 2015; Cattani et al., 2017). Current studies on cognitive structures investigating strategy frames have been focusing on the characteristics of established industries by providing empirical evidence from the firms of that particular industry (Nadkarni & Narayanan, 2007a; Kaplan & Tripsas, 2008; Kiss & Barr, 2015). These studies have resulted in industry-level strategy frames, showing that changes in these frames shape the characteristics of that particular industry, and differences arise from firms' different social networks, generating different assumptions about the environment (e.g. in fast- and slow-changing industries) (Bogner & Barr, 2000; Nadkarni & Narayanan, 2007a). The studies have also theorised organisational forms as socially constructed categories that are revealed in discourse and shape the industry dynamics, proposing that competition involves balancing the similarities and differences in the cognitive categorisation within the strategic groups by the member firms of that group (Porac & Thomas, 2002; Cattani et al., 2017). The key questions for these studies have been the extent to which strategic group membership has influenced firms' performance as well as the extent to which such groups have displayed patterns of competition among the firms (Cattani et al., 2017). Thus, the studies on established industries have shown that competition across firms tends to reflect the interplay between cognitive structures and industry context; for example, firms respond to environmental cues differently in fast- and slow-changing industries (Nadkarni & Narayanan, 2007b; Kiss & Barr, 2015; Hodgkinson, 2015). Thus, *the first research gap* in the studies on industry-level collective strategy frames, which this study intends to address, is related to the appearance of a collective strategy frame within the emerging industry; this question will be answered by measuring the differences in cognitive patterns among the member firms from different industry sectors.

The second identified research gap concerns the dominant logic of the firm and its influence on firm performance. The research in the field has approached organisation-level cognition from both the information processing and cognitive structure perspectives. Recent literature on strategy frame research has shown that dominant logic of the firm as an information filter becomes apparent in management practices and processes that the firm pursues when creating and implementing strategies as well as its relationship with firm performance (von Krogh et al., 2000; Nadkarni & Narayanan, 2007b; Kor & Mesko, 2013; Kyläheiko-Maijanen, 2014). This line of research has mainly focused on studying the existence and direct effect of dominant logic on firm performance (von Krogh et al., 2000; Kor & Mesko, 2013; Schraven et al., 2015), Hence, the current literature lacks knowledge of the influence of the interaction between dominant logic and strategic activities on firm performance. Another line of research theorises dominant logic as a mental construct of the top management which is measured as a shared cognitive structure (Narayanan et al., 2011). Consequently, prior literature addressed the challenge in measuring dominant logic as an explicit cognitive structure at different levels of organisation (Nadkarni et al., 2011; Schraven et al., 2015). Thus, this study addresses *the research gap* in the strategy frame research concerning the influence of the interaction between dominant logic and the firm's strategic activities on firm performance; this research also probes dominant logic at different levels within the organisation as a shared cognitive structure.

The third research gap concerns the managerial cognition research methodology for collecting and analysing high-quality, multilevel data sets from human actors in real-life contexts and operationalising the concept of top managers' shared cognitive structure. In managerial cognition literature, multiple approaches have been used to elicit and analyse managers' cognition. Most research studies have combined different techniques and methods to understand managers' shared cognitive structures better; in contrast, they have paid less attention to their further development (Langan-Fox et al., 2000; Hodgkinson et al., 2004; Tegarden et al., 2009; Ackermann et al., 2014). The recent managerial cognition literature has identified a paucity in development of methods that can provide direct access to human actors' cognitive structures for analysis at different organisational levels (Gnyawali & Tyler, 2005; Tarakci et al., 2014; Hodgkinson et al., 2015; Laukkanen & Wang, 2015; Schraven et al., 2015). Moreover, the literature lacks a conceptual unity of shared managerial cognitive structures and their operationalisations (Nadkarni et al., 2011; Kaplan, 2011; Hodgkinson, 2015; Schraven et al., 2015). Thus, to respond to the aggregation problem of managerial cognitive structures, this study seeks to advance the methodology by eliciting cognitive maps at the individual, organisational and industry levels with the measure of cognitive diversity.

The overall purpose of this thesis is to increase the understanding of the interconnection between the top managers, the firms, and the industry via managerial cognitive structures and their organisational implications. First, it aims to provide new insights for academia, as there is still a dearth of research into the topic. Second, it aims to provide guidance on strategic management for firms that are grappling with the issue of interpreting the developments in fast-changing environments. Finally, this thesis intends to increase the

awareness of policymakers in their actions aimed at cultivating business environments with regard to sustainable business. Hence, the main research question (RQ) for this thesis is as follows:

RQ: How do differences in strategy frames across the firms emerge within the industry?

The main research question is divided into four sub-questions (SQ), which approach the topic from different angles at different levels of analysis. The SQs are studied in five research publications which answer each SQ separately and the RQ as a whole.

The first sub-question focuses on understanding the existence of dominant logic and its relationship with firms' performance. This question is answered in the first publication by analysing survey data among the chief editors of the consumer magazine companies The study is based on the assumption that the top managers as chief editors interpret their environment and make critical decisions on their firms' strategic actions through the firms' dominant logic as an information filter (Bettis & Prahalad, 1995; Kor & Mesko, 2013; Maijanen-Kyläheiko, 2014). The first publication quantitatively explores the interaction between dominant logic and the firms' strategic activities, namely explorative and exploitative innovation activities, and influence of interaction on firm performance. For that purpose, dominant logic as firms' conceptualisation of business (i.e. external environment) and themselves (i.e. internal environment) is operationalised and linked with organisational activities (von Krogh et al., 2000; Schraven et al., 2015). Thus, the first SQ relates to dominant logic and firm performance:

SQ1: How does the interaction between the firm's dominant logic and its strategic activities influence the firm's performance?

While the first sub-question focuses on understanding the relationship between dominant logic and firm performance, the second sub-question focuses on describing the differences between top and middle managers' cognitive structures, assuming that top managers' shared cognitive structure—dominant logic—serves as an information filter for the organisation as a whole (von Krogh et al., 2000; Nadkarni & Narayanan, 2007b). This question is analysed in the second publication using data collected through the cognitive mapping method with distance ratio measure (Langfield-Smith & Wirth, 1992). Prior research suggests that because of different operational task environments and functional positions, top managers' tend to transfer their interpretations to the organisation, shaping the organisation's other levels' sensemaking (Hambrick & Mason, 1984; Beck & Plowman, 2009; Nadkarni & Narayanan, 2007b). Consequently, middle managers are expected to be influenced by dominant logic, as a cognitive product of the top management, and align their views with their top managers (Cho & Hambrick, 2006; Beck & Plowman, 2009; Tyler & Gnyawali, 2009; Schraven et al., 2015). Recent studies have shown that a shared cognitive map reflects dominant logic mainly because it elicits perceptions shared among individuals and, in turn, provides evidence of the existence of dominant logic (Crilly & Sloan, 2012); Schraven, 2015). Thus, the second SQ draws on the information-processing perspective on dominant logic, representing it as a shared

cognitive structure of top management, to identify apparency and dominant patterns of cognitive concepts at different organisational levels:

SQ2: How do the shared cognitive structures differ between the top and middle management within the firm?

The third sub-question focuses on the diversity of organisational cognitive structures and its relationship with organisational outcomes. This SQ is analysed in the third and fourth publications. The third publication analyses the cognitive structures of the top decision-makers in terms of issue centrality and cognitive diversity by linking the cognitive mapping method with distance ratio and network centrality measure (Langfield-Smith & Wirth, 1992; Bonacich, 2007); this is based on the assumption, suggested by prior research, that diversity in cognitive structures arises from the differences in individual characteristics and organisations' strategic environments (Hambrick & Mason, 1984; Marckozy & Goldberg, 1995; Nadkarni & Narayanan, 2007b; Schraven et al., 2015). The fourth publication examines the problem of cognition aggregation at different organisational levels by analysing decision-makers' cognitive structures using the cognitive mapping method with distance ratio and linking them with organisational performance (Langfield-Smith & Wirth, 1992; Tyler & Gnyawali, 2009; Powell et al., 2011; Laukkanen & Wang, 2015; Schraven et al., 2015). Thus, the third SQ focuses on the generative mechanism across multiple levels of analysis from the individual to the organisation, inter-organisation and (inter-) industry levels by examining the managers' cognitive structures, demographic characteristics and the firms' operative environment and their connection with the firms' performance:

SQ3: What is the relationship between cognitive diversity and (a) firms' interpretation (b) and firms' outcomes?

The fourth sub-question deals with the industry-level cognitive structure (i.e. collective strategy frame). The fifth publication analyses the collective strategy frame and its development patterns over time by examining annual reports of the cleantech firms from 2009–2016. The cognitive construction view of industry assumes that reality is a socially constructed phenomenon, suggesting that the firms in an industry interact within their networks and create collective beliefs about development, boundaries and related competition of that particular industry (Porac et al., 1989; Bogner & Barr, 2000; Nadkarni & Narayanan, 2007b; Cattani et al., 2017). These collective beliefs establish a collective strategy frame, which then shape the character of the industry by giving frames to individual firms' actions and strategies (Nadkarni & Narayanan, 2007a; Tyler & Gnyawali, 2009). Thus, the fourth SQ sheds light on the development of collective strategy frames across cleantech industry firms:

SQ4: How does the collective strategy frame develop over time among the incumbent firms?

Thus, the main research question and the four sub-questions provide insights into the research topic of the thesis. Each publication contributes to its sub-questions and the main research question by explaining the complex relationship between the individual managers', firms' and the industry-level cognitive structures and organisational outcomes. The research questions, publications and analysed data are shown in Table 1.

Table 1. Summary of the research questions, publications and data.

The main research question: How do differences in strategy frames across the firms emerge within the industry?		
SQ1: How does the interaction between the firm's dominant logic and its strategic activities influence the firm's performance?	**Publication 1**: Managerial cognition and dominant logic in innovation management: Empirical study in media industry	**Data collection**: Survey in 2012
SQ2: How do the shared cognitive structures differ between the top and middle management within the firm?	**Publication 2**: Information processing approach in organisational cognitive structures: Relationship between top and middle managers' cognitions.	**Data collection**: Cognitive maps in 2015
SQ3: What is the relationship between cognitive diversity and (a) firms' interpretation (b) and firms' outcomes?	**Publication 3:** Strategic interpretation on sustainability issues—eliciting cognitive maps of boards of directors **Publication 4**: Cognitive diversity, managerial characteristics and performance differences across the cleantech firms	**Data collection**: Cognitive maps in 2014
SQ4: How does the collective strategy frames develop over time among the incumbent firms?	**Publication 5**: Emergence and development of the cleantech industry: A cognitive construction approach	**Data collection**: Annual reports (2009–2016) in 2017

1.3 Positioning of the study

The overall goal of this thesis is to increase the understanding of how strategy frames are created and linked to organisational activities; it also aims to show how their relationships can be measured at different levels of analysis. The behavioral perspective on studying the strategy has gained increasing attention by the scholars since Cyert and March (1963)

introduced their behavioural theory of the firm. This line of studies taking the cognitive perspective in strategy research has provided several important research strands for investigation, including behavioural decision research (Tversky & Kahneman, 1986; Kahneman & Lovallo, 1993), cognitive structures and categorisation (Axelrod, 1979; Porac et al., 1989; Lyles & Schwenk, 1992; Tyler & Gnyawali, 2009; Cattani et al., 2017), attention and sensemaking (Dutton & Duncan, 1987; Weick, 1979, 1995; Ocasio, 1997; Ocasio et al., 2017), managerial dominant logic and strategy frames (Daft & Weick, 1984; Hambrick & Mason, 1984; Prahalad & Bettis, 1986; Nadkarni & Narayanan, 2007b) and industry boundaries (Porac et al., 1989; Huff, 1992; Bogner & Barr, 2000; Nadkarni & Narayanan et al., 2007a). These studies have provided diverse research topics and methodological approaches for strategy research, setting an agenda for integrative studies (Powell et al., 2011; Hodgkinson, 2015).

Based on these research strands, this thesis integrates two literature streams of managerial cognition research in the field of strategic management, namely the strategic schema literature (Daft & Weick, 1984; Prahalad & Bettis, 1986; Lyles & Schwenk, 1992; Nadkarni & Narayanan, 2007b) and the literature on the cognitive construction view of industry (Berger & Luckmann, 1967; Reger & Huff, 1993; Bogner & Barr, 2000; Nadkarni & Narayanan, 2007a). This research is grounded in constructivism and phenomenology which emphasise the importance of context when conducting empirical research; this means that cognition is a product of human interaction in relation to their environment (Powell et al., 2011). Both literature streams assume that the organisation is a reflection of its top managers' 'shared world view'—strategy frame—shaping the firm's strategies and its actions; these frames are socially constructed among a particular network of firms (e.g. an industry), creating collective behavioural boundaries across the firms. Furthermore, this line of studies argue that strategy frames have their unique development paths, contents and structures which lead organisations to make different choices concerning the environment and other organisations (Hambrick & Mason, 1984; Bogner & Barr, 2000; Tripsas & Gavetti, 2000; Nadkarni & Narayanan, 2007a; Kaplan & Tripsas, 2008; Martignoni et al., 2016).

According to the strategic schema literature, managers' causal explanations and acts in their environments are connected to their cognitive frames (Walsh, 1995). These frames are bundles of cognitive structures that are developed through experience and stored in the memory as higher-level abstractions of interconnecting events, which allow individuals to cope with and have expectations of others' behaviour responding to forthcoming situations (Abelson, 1981; Gentner et al., 1993). Of particular importance for the strategic schema literature is that cognitive act is considered a social endeavour and, therefore, is situated and influenced by other people (Fiske & Taylor, 2008). In strategy research, this line of research has been focusing on understanding how knowledge is organised in cognitive structures, how through interaction these cognitive structures evolve into organisation-level cognitive structures (i.e. strategy frames) (Laukkanen, 1990; Langfield-Smith, 1992; Lyles & Schwenk, 1992; Hodgkinson et al., 2004; Nadkarni & Narayanan, 2007b) and how these strategy frames shape organisations'

strategic activities by providing managers 'cognitive lenses' to analyse the environment (von Krogh et al., 2000; Nadkarni & Narayanan, 2007b; Maijanen-Kyläheiko, 2014).

Research taking the cognitive construction view of industry originates in Berger and Luckmann's (1967) idea of a socially constructed reality, assuming that the firms in an industry interact with each other and create collective assumptions about a particular industry development, boundaries and related competition, which, in turn, drive industry development (Porac et al., 1989; Bogner & Barr, 2000; Nadkarni & Narayanan, 2007a). This research stream has gained its prominence by studying the relationship between managerial cognition and industry characteristics (Nadkarni & Barr, 2008; Hodgkinson, 2015; Cattani et al., 2017). This research has studied when and how organisations change their collective strategy frame (Reger & Huff, 1993; Nadkarni & Narayanan, 2007a; Tyler & Gnyawali, 2009) and how firms' social networks influence and interpret the information they receive (Porac & Rosa, 1996; Nadkarni & Narayanan, 2007a; Kaplan & Tripsas, 2008; Tyler & Gnyawali, 2009; Paolella & Durand, 2016). For example, firms operating in fast- and slow-changing industry conditions develop different collective strategy frames, offering them different strategic choices (Kaplan, 2008a; Benner & Tripsas, 2012).

This thesis aims to capture the complex and interdisciplinary phenomenon of managerial cognition in strategic management. By combining these two literature streams, top managers' cognitive structures at different levels of analysis can be studied to gain insights into the interconnection between the top managers, the firm, and the industry and its organisational implications. Thus, through this combination of literature strands, the thesis intends to provide academia with new information to fill the gap in integrative studies about how top managers' cognitive structures aggregate into higher organisational levels and what its outcomes are (Narayanan et al., 2011; Powell et al., 2011; Hodgkinson, 2015). Additionally, this thesis aims to inform both managers and policymakers of the indications of the changes in industry characteristics. Figure 1 displays a summary of the discussion above.

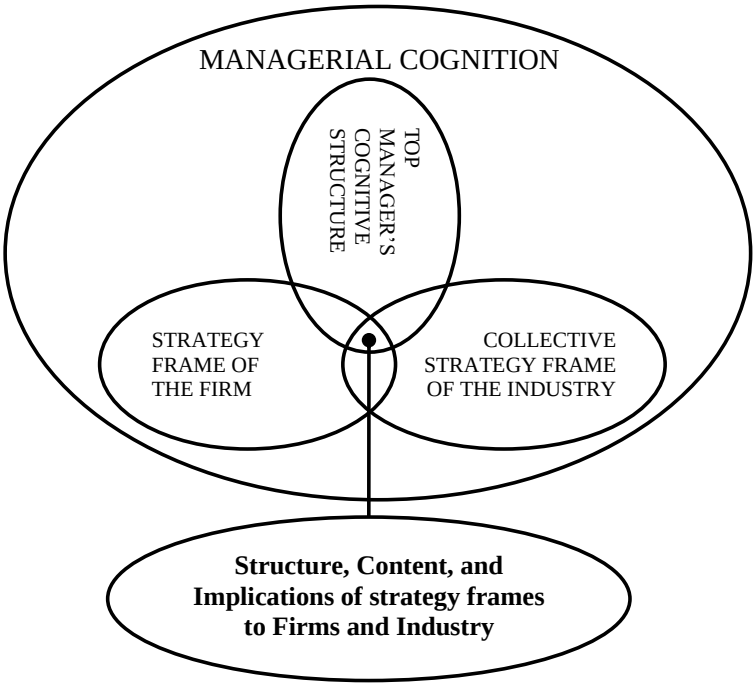

Figure 1. The focus of the research.

2 Theoretical point of departure of the study

Managerial cognition research in strategic management applies both cognitive and social psychology to theory and practice, addressing the central problem of firm heterogeneity and its persistence in strategy research. The research seeks to understand 'the linkage between cognitive structures and decision processes in strategic management with respect to strategy formulation and implementation' (Porac & Thomas, 2002): 165). These cognitive structures are embedded in top managers' beliefs about the industry conditions, firms' strategy and business and the organisation; they differ from behavioural decision research by concentrating on cognitive representations of business environment and organisation (Porac & Thomas, 2002). This line of research aims to create realistic assumptions about managers' perceptions and social behaviour, stressing the importance of structures and processes of cognition in explaining firms' strategy and performance outcomes (Narayanan et al., 2011). In addition, research assumes that the environment is enacted and that, through interaction, individual managers actively influence the characteristics of the competitive environment (Daft & Weick, 1984; Narayanan et al., 2011). However, several studies have been pointing out the lack of conceptual unity, requiring integrative approaches with multiple methods to bring the cognitive perspective in strategic management closer to empirical facts (Powell et al., 2011; Hodgkinson, 2015; Cattani et al., 2017). Over the years, this line of research has attracted great academic interest at different levels of analysis, namely individual, group, organisation and industry. Given that two literature streams, namely the strategic schema and the cognitive construction view of industry have inspired this research, this thesis intends to investigate decision-makers' cognitive structures at multiple levels of analysis; it will draw on the findings of these analyses to explain the organisational outcomes.

2.1 Strategy frames in organisations

Strategy frames are shared cognitive structures of top managers, representing organised knowledge and beliefs about the environment, strategy, business portfolio and organisation of a firm (Porac & Thomas, 2002). Managerial cognition research has been based on the assumption that bounded rationality limits top managers from creating a comprehensive understanding of their business environments (Prahalad & Bettis, 1986; Bogner & Barr, 2000; Kaplan & Tripsas, 2008). Consequently, top managers create a subjective representation of the environment, which, in turn, shape their strategic choices and the organisation's actions (Thomas et al., 1993; Gavetti & Rivkin, 2007). In this process, strategy frames act as cognitive lenses through which top managers can interpret information and convert it into the firm's strategic actions (Huff, 1982).

Strategy frame is a cognitive structure of a particular group of people, and its origin is in the individual level cognitive concept of the script. Scripts explain how an individual actor interpret a situation and perform coordinative action in that situation (Erasmus et al., 2002). Scripts are memory structures that are developed over time and stored in the long-term memory as representations of a reality that allow individuals to cope with their environments and anticipate others' behaviour (Abelson, 1981). Scripts consist of frames

that are used to organise knowledge about specific objects and topics that are interconnected to create an integrated whole (Abelson, 1981). Thus, scripts are linked to a particular experience and hold knowledge about a specific knowledge domain, including causal relationships among its attributes as generalised, simplified organisations of experience that serve initial frames of reference for interpretation and action against similar experiences (Weick, 1979). As scripts evolve from experience into generated action for specific goals, scripts may offer multiple paths to those goals, creating flexibility or adaptability for behaviour (Abelson, 1981). Flexibility and adaptability arise from the content and structure of scripts, which provide multiple paths for action. Scripts comprise strong and weak concepts; strong concepts are explicit and inform what actions and constraints must occur whereas weak concepts are vague and provide performance options for different situations (Abelson, 1981). Thus, managers' ability to receive, store, retrieve and utilise information is connected to the structural characteristics of cognitive structures, which offer managers frames in a particular event or situation for purposeful actions (Weick, 1995).

Cognition is also a social endeavour, which is always situated and influenced by other people (Levine et al., 1993). By interacting with each other in a particular social group, the group members develop a shared cognitive 'product' (cognitive frame/cognitive structure), which is embedded in the commonly accepted values, norms and beliefs of the environment and influences individuals' interpretations and responses to information they receive (Levine et al., 1993). Consequently, in managerial cognition research, organisations are widely seen as interactive 'interpretation systems' that collect information and interpret it through the beliefs shared throughout the organisation (Daft & Weick, 1984). Many organisation members may participate in this interactive process; however, top managers have a particular role in it. The upper echelon view contends that top managers collate and interpret the information for the firm as a whole (Hambrick & Mason, 1984). Their cognitive structures act as filters through which they scan and interpret information and make critical choices for the future (von Krogh et al., 2000; Kaplan & Tripsas, 2008; Schraven et al., 2015). By interacting with each other, the top management creates a general managerial dominant logic of the firm that defines 'how managers conceptualize the business and make critical resource allocation decisions—be it in technologies, product development, distribution, advertising, or in human resource management' (Prahalad & Bettis, 1986: 490). Dominant logic refers to the shared cognitive structure that top managers use when making sense of the environment during their strategic decision processes (Schraven et al., 2015). At the firm level, strategy frame represents cognitive construction of strategies, which drives its members to the selective consideration of all 'available' information around it and provides an opportunity to direct the limited resources and attention to the events or situations essential to the firm's success (Lyles & Schwenk, 1992; Bogner & Barr, 2000; Narayanan et al., 2011). In addition, strategy frames act as cognitive lenses that enable managers to interpret information about the current environment and anticipate the behaviour of the competitive environment (von Krogh et al., 2000; Hodgkinson et al., 2009; Levine et al., 2017). In other words, such cognitive structures reflect the commonly understood, accepted and disseminated repertoire of managers' beliefs of the environment, which

makes it possible to filter the information but also make sense of it and envision the alternative options for future strategies.

Thus, what is crucial for firms' strategy making is to understand what strategy frames are holding in (Hodgkinson & Clarke, 2007; Schraven et al., 2015). Strategy frames shape top managers' conceptualisation of the environment; they direct managers' attention to information that is embedded in the core of the frames, enabling the implementation of the strategies until unrecognisable information emerges (Kaplan, 2008; Hodgkinson et al., 2009; Kiss & Barr, 2015). Depending on the firm's history, the strategy frame is ordered in a particular form around the 'core and peripheral' concepts as scripts; the strategy frame enables the firm to be aware of emerging changes in the environment and helps develop new strategies (Nadkarni & Narayanan, 2007b; Cattani et al., 2017). As strategy frames are unique to firms, they also contain 'peripheral' weak concepts outside the core with minimal influence on managers' perceptions, although they may enable managers to confront the inappropriate information that is not supported by the underlying assumptions embedded in the core concepts of the strategy frame (Lyles & Schwenk, 1992; Kiss & Barr, 2015). Empirical research has reported mixed results on the influence of strategy frames on firms; this is mainly because the path dependency of the strategy frame may cause incapability and inertia of performance in the changing environment. Firms may be locked into their current businesses and discard new information from the environment and, in turn, miss the opportunity to change their behaviour to meet the requirements of the changing environment (Kaplan, 2008b; Santos et al., 2015).

Prior research has shown that managers' cognitive structures can be inaccurate, and significant heterogeneity can also exist among the managers within the organisation and across organisations (Eggers & Kaplan, 2009). For example, managers often have simplified cognitive structures that preclude them from capturing all complexities of the environment they are experiencing (Bettis & Prahalad, 1995; Schraven et al., 2015). Such simplification may arise from information overflow, including many interdependencies to distinguish, or managers may be affected by superstitious learning, creating beliefs about contingencies that do not exist (Martignoni et al., 2016). Some studies have also suggested that simplified or inaccurate cognitive structures may be beneficial, allowing managers to overcome inertial tendencies in uncertain conditions during strategic decision-making (Kaplan, 2008b); this has raised questions about the origin of managers' different cognitive structures. Individual managers have different backgrounds, ranging from various knowledge bases to different values, experiences and organisational positions; these variations create a foundation that helps managers interpret information from their environments and contribute to their organisation's cognitive operations (Cho & Hambrick, 2006; Huber & Lewis, 2010; Eggers & Kaplan, 2013). Empirical studies have shown that top managers' demographic backgrounds influence their perception and interpretation of their strategic environments; for instance, the educational background can influence the interpretation of technological changes in the industry (Cho & Hambrick, 2006; Eggers & Kaplan, 2009). Thus, cognition is personal and interactive, and diversity is an inherent feature of cognitive structures, arising from individual

characteristics (e.g. age, education and experience) and cultural and institutional issues such as shared norms and values of a wider population (e.g. the industry) (Hambrick & Mason, 1984; Eggers & Kaplan, 2009; Tyler & Gnyawali, 2009; Schraven et al., 2015).

Strategy frame is an organisation-level structure; however, differences in strategy frames can be observed in their complexity and focus, stemming from managers' subjective interpretations (Nadkarni & Narayanan, 2007b). Complexity informs differentiation and integration in strategic frames whereas focus reflects the centrality degree of the shared elements of the frames around the core concepts within a specific group of actors (Nadkarni & Narayanan, 2007b). Several studies have shown that diversity in terms of complexity and focus is a distinct facet of cognitive structures and a key issue determining the existence and meaning of strategy frames in organisations' behaviour (Nadkarni & Narayanan, 2007b; Tyler & Gnyawali, 2009). The studies have investigated cognitive diversity using either direct or indirect measures, reporting mixed results in organisational cognitive outcomes (Kilduff et al., 2000; Narayanan et al., 2011). For example, a variety of perspectives in sensemaking processes hold that cognitive diversity may lead to a group's lengthy strategic negotiations before they can arrive at a final decision and diminish the organisational responsiveness to environmental changes (Markoczy, 2001; Martignoni et al., 2016). On the extreme end, the cognitive similarity of a decision-making group may divert attention to the emergent opportunities and threats in an organisation's business environment (Martignoni et al., 2016). For example, some firms in the imaging industry did not perceive the progress of digitalisation and failed to modify their strategies to meet new business conditions (Tripsas & Gavetti, 2000); similar failures, challenges and opportunities can be witnessed in many other technology-driven fields (Kaplan, 2008a).

In summary, the strategy frame as an organisation-level cognitive structure is essentially an individual-level cognitive concept (Laukkanen, 1990; Bogner & Barr, 2000; Schraven et al., 2015; Cattani et al., 2017); they are influenced by social interaction, giving rise to commonly shared assumptions about competitive environment within a given social grouping and leading to the occurrence of shared cognitive structures among the individuals, firms and a wider population of actors (Bogner & Barr, 2000; Thomas & Porac, 2002; Narayanan et al., 2011). The empirical research has often presented strategy frames in terms of content and structure, identifying several key characteristics such as homogeneity versus heterogeneity, core versus peripheral cognitive elements of strategy frames and focus versus complexity to explain differences between the firms and their behaviours (Lyles & Schwenk, 1992; Hodgkinson et al., 2004; Tyler & Gnyawali, 2009; Hahn et al., 2014).

2.2 Collective strategy frames within an industry

Initially, the strategy frame is a construct of individual-level cognitive concept; however, it evolves in the interaction between the environment and individual managers (e.g. Walsh, 1995). By interacting within their environments, top managers work with several individuals who share ideas and knowledge in their organisations and wider stakeholder

networks (e.g. within an industry group); through interaction, managers create similarity in their beliefs and actions, developing industry-level cognitive structures (Bogner & Barr, 2000; Nadkarni & Narayanan, 2007b). Consequently, if the interpretations of competition within an industry were equally shared among the firms, there would hardly be any differences between firms' actions (Spender, 1989). Nevertheless, if interpretations vary between firms within an industry, firms will engage in different actions and may gain a competitive advantage or otherwise among their competitors. Managerial cognition research, theory development and empirical research have been grappling with the issue of industry boundaries to varying degrees of intensity since the 1980s, basing their explanations on cognitive construction of competition (Kaplan, 2011; Hodgkinson, 2015; Cattani et al., 2017).

The research in competitive industry structures originates in the deterministic tradition of industrial organisation economics (Porter, 1979; Caves et al., 1984). Conversely, managerial cognition research takes an actor-oriented perspective when studying industry structures and suggests that firms' environments are not purely exogenous but mediated by managers' interpretations developed in the social networks; this means that, through the social exchange of information, actors develop a shared understanding of how to compete and who the competitors are in that environment (Huff, 1982; Porac et al., 1989). This social science and social psychology perspective opened a new research stream into strategic management, arguing that the competitive environment is a socially enacted, shared phenomenon (Berger & Luckmann, 1967; Weick, 1979; Porac et al., 1989; Tsoukas, 1996). The cognitive construction view of industry, based on Berger and Luckmann's (1967) idea of a phenomenon of a socially constructed reality among the members interacting in that particular social context, has raised a strong promise to explain the differences in firms' strategies (e.g. during the industry transformation) (Kaplan, 2008; Nadkarni & Narayanan, 2007a; Cattani et al., 2017). The cognitive construction view of industry assumes that the firms in an industry interact with each other, and during that interaction firms' members perform continuous 'objective-subjective-objective cycle of perception' and create collective beliefs about a particular industry development, boundaries and related competition (Porac et al., 1989; Bogner & Barr, 2000; Nadkarni & Narayanan, 2007a). Central to the collectively constructed strategy frames is the fundamental understanding that the competitive environment and firms' roles they are holding are available and shared across the industry members. Besides the commonly shared beliefs about the boundaries of the competitive environment, the collective strategy frame includes differentiating unique knowledge of the firms for which firms strive and develop to gain competitive advantage over their competitors; in turn, this creates heterogeneity in firms' actions and drives changes in/persists the existing industry conditions (Huff, 1982; Lyles & Schwenk, 1992; Tsoukas, 1996; Nadkarni & Narayanan, 2007). Thus, these collective beliefs of industry-level norms, values, memberships and competitive boundaries set a collective strategy frame for the industry members by imposing constraints on their actions and character of the industry (Nadkarni & Narayanan, 2007; Cattani et al., 2017).

Prior research has shed light on the complex phenomenon of collective strategy frame by representing cognitive structures and demonstrating their existence in different research settings (Kaplan, 2011). Studies on the cognitive categorisation of rivalry provide a cognitive approach viewing competition as constructed by multiple actors through their interpretative lenses; the approach theorises the cognitive categories of competition as basic elements of an enacted environment (Hodgkinson, 2015). Cognitive categories can be considered a collective typification of a competitive environment where groups of actors interpret the similarities between the organisations and abstract them as higher-level groups of similar types of organisations (Cattani, 2017). This common conceptualisation of the industry boundaries, memberships and competitive advantages generates similarities in firms' actions and strategies when firms are observing and interacting with each other (Porac & Thomas, 1990; Surroca et al., 2016). Prior research has also studied industries as belief systems that direct the attention of organisations towards peers who sustain the development of industry-specific logic for action and reinforce the rule systems for strategic decisions (Spender, 1989; Barley & Tolbert, 1997). Rule systems are seen as self-reinforcing and taken for granted and can be challenged only by external industry members (Porac et al., 1989). In sum, collective strategy frames are socially constructed representations of reality, which include both common understandings of competition and individual firms' unique knowledge which are accessible to other industry members (Nadkarni & Narayanan, 2007a). In this sense, interaction among the firms within an industry creates cohesion in the firms' beliefs of competition and actions and lead industry-level cognitive structures (i.e. strategy frames), maintaining industry conditions by either driving the change or reinforcing the existing conditions over time. Hence, these collectively constructed strategy frames enable coordinative actions by creating a common boundary for attending and interpreting new information and guiding purposeful actions (Bogner & barr, 2000).

Empirical research in collective strategy frames have been investigating the consensual degree of strategy frames among actors within and across organisations, showing that strong homogeneity and heterogeneity have positive and negative impacts on organisations and industries (Thomas & Porac, 2002; Narayanan et al., 2011; Hodgkinson, 2015). For example, incumbent firms are those that have been learning from each other's actions and potentially share more common beliefs of the environment, exhibit more unity in their strategies and carry out more collective actions compared to new venture firms (Kiss & Barr, 2015). Relating to the same phenomenon, changes in the strategy frames of the core group of firms lead changes in collective behaviour across the firms in that particular industry, which, in turn, generate changes in industry-level assumptions and network activities, perpetuating the industry transition (Nadkarni & Narayanan, 2007a; Tyler & Gnyawali, 2009). These and related studies show that the firms' interactive social networks influence the information that firms receive and interpret and drive firms with different social networks to react to environmental changes within the industry. For example, aircraft industry firms during the upheaval changed their collective strategy frame by focusing on and simplifying the frame and strengthening network relations to overcome information overload caused by the changing industry conditions (Nadkarni & Narayanan, 2007a). Thus, the focus of industry-level managerial

cognition research has been on the categorisation of the competitive environment into strategic groups and how collective cognitive structures influence industry formation (Narayanan et al., 2011).

2.3 Eliciting and measuring cognitive structures in organisational settings

Eliciting and measuring managers' cognitive structures are great challenges in strategic management research for many reasons. First, there is hardly any direct access to measure and represent knowledge and information stored in human memory (Healey & Hodgkinson, 2014). Also, because strategy frames are socially constructed cognitive structures it may raise questions about the ontological status of cognitive structures as representations of objective realities connecting organisational actions to the environment and shaping the character of that environment (Nadkarni & Narayanan, 2007a; Lee & Kwon, 2014). Research in strategic management has been applying psychological concepts and techniques to gain a better understanding of the relationship between cognitive structures and firms' strategies (Hodgkinson, 2001; Narayanan et al., 2011). Over the years, strategy scholars have developed empirical portrayals of organisational cognitive structures based on the central idea of knowledge of the interrelationships between the cognitive concepts in a domain (i.e. the knowledge that a manager has of a situation or task, stored in the long-term memory as scripts) (Abelson, 1981; Langan-Fox et al., 2000); this has enabled strategy scholars to assume that cognitive structures have measurable structural characteristics in terms of content and structure. At the individual level, elaboration and interpretation have been applied to central characteristics in research on decision-makers' cognitive structures (Hodgkinson & Clarke, 2007). Interest in empirical studies for organisation-level cognitive structures has been focusing on heterogeneity versus homogeneity and the differences between core and peripheral concepts of the cognitive structures within and across organisations and how they are organised in terms of focus and complexity (Nadkarni & Narayanan, 2007b; Kiss & Barr, 2015). Research in wider populations has been dealing with the problem of aggregation, focusing on the issue of consensus on cognitive structures of competitor definition within and between organisations in industries as shared beliefs about the boundaries of competition by analysing social interaction and inter-organisational performance differences (Hodgkinson, 2015).

Despite uncertainties or even ontological issues related to elicitation and measuring cognitive structures in different organisational settings, managerial cognition research has suggested a simple syllogism for understanding cognition in organisations: 'people think, and as managers are people, managers, therefore also think; and since these cognitive processes take place in an organizational setting, these studies can be considered as analysis of cognitive processes in organizations' (cf. Nicolini, 1999: 833). The managerial cognition research points out that approaches to describing, simulating or anticipating thinking is a problematic issue and therefore capturing managers' cognitive structures provides only representations of representations, and methods should be considered instruments of display cognitive structures, aiding analysis of situations and events

regarding strategic decision-making, for example (Laukkanen, 1998; Nicolini, 1999; Hodgkinson et al., 2004). Due to the difficulty of capturing and representing cognitive structures, which are invariably unique and temporary constructs, the validity of methods and efficacy of techniques have been discussed widely in managerial cognition research. Some scholars have suggested that the relationship between the 'true' and revealed cognitive structure is never ideal and is influenced by the social context and the moment in which it takes place (Gnyawali & Tyler, 2005; Hodgkinson, 2015). By taking into account both ontological and epistemic cautions about the representation of organisational cognitive structures, these cautions can provide insights into what managers believe and perceive (Axelrod, 1979; Gnyawali & Tyler, 2005; Hodgkinson, 2015; Laukkanen, 2018).

Using cognitive structures, the literature has provided compelling results to analyse and explain organisational outcomes. Consequently, the strategy frame concept from different definitional perspectives (strategy schema, dominant logic, belief structure, cognitive structure) has gained widespread empirical attention at different levels of analysis, grounding its origin in the individual-level cognitive concept of script (Prahalad & Bettis, 1986; Hodgkinson, 1997; Mitchell et al., 2000; Nadkarni & Barr, 2008; Tyler & Gnyawali, 2009). At the individual level, the studies have investigated the structural characteristics of strategy frames and their linkage to executives' beliefs of the environment and intentions to take different actions and, in turn, their mediation of the organisation's performance (Laukkanen, 1998, 2018; Markoczy, 2001; Nadkarni & Narayanan, 2007b; Kaplan, 2008b; Hahn et al., 2014). These studies have aimed to represent perceived reality by relying on managers to provide evidence that individual managers' cognitive structures shape their strategic activities, depending on the internal and external conditions in which managers operate as well as the characteristics of individual managers (Markoczy, 2001; Cho & Hambrick, 2006; Tyler & Gnyawali, 2009). Generally, the studies suggest that due to bounded rationality, managers develop a limited understanding of the information they receive from the environment, and instead, managers construct subjective representations of that environment, which, in turn, shape managers' actions and mediate the organisation's responses to the environment (Fiol & O'Connor, 2003; Nadkarni & Barr, 2008; Hahn et al., 2014). This line of research has applied both direct and indirect measures to investigate strategy frames, although it continues calling for more research on control over key contextual and organisational factors and more comprehensive analysis of cognitive structures (Narayanan et al., 2011).

Drawing on the empirical research on cognitive structures of wider populations, the researchers have stressed the archival sources and surveys to explore antecedents and outcomes with industry as a moderator to trace the strategic action of firms (Nadkarni & Narayanan, 2007b). The research has widely used archival sources for elicitation and analysis of strategy frames and surveys to capture managers' beliefs and assumptions about the environments at group, organisation and industry levels, promoting strategic activities of the firms and the cognitive construction of industries (Bogner & Barr, 2000; Nadkarni & Barr, 2008; Maijanen-Kyläheiko, 2014; Cattani et al., 2017). Narayanan et

al. (2011) highlighted two important notions in their review. First, the empirical studies have mostly been conducted in mature industries, limiting the distinction between perceived and enacted environments, and second, the findings suggest a correlation between antecedents and strategy frames, in the sense that the content of the strategy frame reflects the context of the firm, and the structure displays the environmental conditions. Thus, this line of empirical research in the strategic context investigates cognitive phenomena in strategy development and implementation by focusing on cognitive representations of environment and organisation; this way, it departs from behavioural decision theory, although it notices the cognitive heuristics and biases (Narayanan et al., 2011).

Recently, the strategic management research in cognitive structures in organisational settings has stressed the need for comprehensive studies to tackle the scaling problem of cognition (Powell et al., 2011; Narayanan et al., 2011). This study aims to intrude into the complex phenomenon of managerial cognition at different levels of analysis to develop the methodology for the analysis of cognitive structures to operationalise the concept of the strategy frame at multiple levels of analysis; it also intends to develop mathematical measures to gain more information embedded in managers' cognitive structures. Thus, previous managerial cognition research in strategic management highlights the importance of top managers' cognitive structures as a key explanation for firms' behaviour and construction of industries; this thesis will exploit these studies and utilise that understanding in its research.

3 The research design of the study

First, this chapter discusses the philosophical and methodological backgrounds and choices of this thesis. Then the discussion continues with the evaluation of the quality of the research. Finally, the research design, data collection and analysis are presented.

3.1 Philosophical assumptions

This thesis is built on the assumptions about critical realism on reality, following the mixed methods research design in studying the emergence of differences in cognitive structures across the firms. This thesis is also exploratory research by nature because it employs multiple methods to investigate the phenomenon under consideration. When studying managers' cognitive structures, as in this thesis, it is about investigating the representations of the environment created by social actors (Nicolini, 1999); this generates the important philosophical discussion on ontological and epistemological issues of reality and knowledge related to the research design of this thesis.

Ontology focuses on the existence of reality and its independence of our knowledge. The investigated reality can be considered external to the individual or a construct of individual consciousness by arguing that reality is a given 'out there', or it can be seen as the construct of an individual's mind (Burrell & Morgan, 1979). In other words, ontology is about the existence of the world and society. Key ontological perspectives vary between objectivism (empiricism) and subjectivism (interpretivism) of reality, depending on the

researcher's worldview. Subjectivism is often linked to research on social systems as constructionism (Eriksson & Kovalainen, 2008). Constructionism assumes that individuals are social actors and that reality is created within the interactive social context existing in individuals' minds only, and in this sense, the reality is assumed as being subjective (Berger & Luckmann, 1967; Abelson, 1981; Eriksson & Kovalainen, 2008; Hodgkinson, 2015). This thesis relies on social studies and thereby, ontologically, approaches reality as a socially constructed phenomenon allowing the investigation of cognitive structures by assuming that they display reality as perceived by top managers.

Epistemology seeks to understand whether it is possible to observe reality objectively, or the observation is bounded by the observer's subjective understanding of the world (Burrell & Morgan, 1979). Epistemology probes the nature of knowledge, its limitations and what knowledge can be obtained (Eriksson & Kovalainen, 2008). As this thesis concerns social studies and constructionism (Berger & Luckman, 1967; Zachariadis et al., 2013; Hodgkinson, 2015), it assumes that social actors construct reality and, therefore, influence the kind of knowledge that can be obtained and how an observer can distil the 'truth' and 'false' from the flow of knowledge (Burrell & Morgan, 1979).

Given the mixed methods research design and social constructivist approach of this thesis, the ontological, epistemological and methodological stance of this study lies in a middle position between naïve realism and naïve relativism (Johnson & Onwuegubuzie, 2004; Zachariadis et al., 2013). Naïve realism represents the extreme form of positivism and advocates a reality that is objective and empirically observable; naïve relativism, in contrast, proposes that there are multiple local and specially constructed realities which exist only in texts and interpretations (Järvensivu & Törnroos, 2010; Hodgkinson, 2015). A researcher who positions his/her study between these two extreme ends of critical realism believes that there exists an observable reality independent of our knowledge, which is only imperfectly and probabilistically apprehensible in terms of epistemology (Easton, 2010). Thus, critical realism strongly emphasises that ontology is an independent reality and that the generation of knowledge is a human activity (Zachariadis et al., 2013). This conception is important when conducting studies on social systems (e.g. business organisations). In such contexts, conditions are rarely controllable and accurately measurable, and therefore, validity, reliability and generalisability become vital issues. Hence, critical realists search for 'truth' through triangulating empirical evidence by collecting substantial valid and reliable information and controlling the data collection process to eliminate possible sources of bias, error or misunderstanding (Easton, 2010; Hodgkinson, 2015). Thus, ontologically, epistemologically and methodologically, this thesis positions itself between naïve realism and relativism, aligned with critical realism; it seeks to gain a holistic understanding and explanation of the differences in cognitive structures at individual, firm and industry levels as well as their organisational implications.

Besides the philosophical considerations, the selected theory and personal values influence the research approach of the study (Bryman & Bell, 2003): 99). Personal values may cause bias and affect the quality of the study. However, these are important aspects

of methodological choices, which often reflect the researcher's axiological assumptions (Bryman & Bell, 2003; Turner et al., 2015). The theory itself may suggest a particular approach and method, depending on the maturity of the research field; this is important because qualitative methods tend to support research on topics that have received limited attention in the literature whereas quantitative methods are often seen appropriate for mature research fields (Bonoma, 1985). Nonetheless, the research topic and questions provide central guidance on the research's choice of method (Bryman & Bell, 2003; Eriksson & Kovalainen, 2008). In this thesis, the theoretical perspective in managerial cognition in the field of strategic management suggests integrating research approaches with multiple methods to enhance theory building and gain coherence in the field (Huff, 2005; Narayanan et al., 2011; Powell et al., 2011; Hodgkinson, 2015).

3.2 Methodological choices

This study follows a mixed methods research approach, and hence, it has a qualitative emphasis complemented with quantitative data collection and analysis. When selecting the methodology, the topic and the theory inherently shape the researcher's methodological choices (Bryman & Bell, 2003). Prior studies in managerial cognition, especially strategy frames grounding their theoretical assumptions in social studies, suggest a comprehensive approach with multiple methods to advance theory building and methodological development (Huff, 2005; Narayanan et al., 2011; Powell et al., 2011).

Qualitative research represents a collection of different research approaches that aim to provide a holistic understanding of a topic or phenomenon (Eriksson & Kovalainen, 2008). Qualitative research methods are often useful for generating rather than testing a theory; they enable investigating new phenomena and exploring new settings to gain an in-depth understanding of a phenomenon (Eisenhardt, 1989a; Johnson & Onwuegubuzie, 2004). One of the issues of qualitative research is the generalisability of results and causal relationships (Bryman & Bell, 2003). *Quantitative methods*, on the other hand, are focused on deduction, confirmation, theory/hypothesis testing, explanation, prediction and statistical analysis. In mixed methods research, quantitative methods provide important generalisation of events, which enables the further investigation of mechanisms that gave rise to those events in the first place (Zachariadis et al., 2013). Quantitative methods can also be used to test the theories derived from qualitative data (Zachariadis et al., 2013). Besides, mixed methods research can open new opportunities to describe and develop techniques and allow the techniques to come closer to what studies actually use in practice (Johnson & Onwuegbuzie, 2004). Thus, mixed methods research enables the use of qualitative and quantitative viewpoints for data collection and analysis for a holistic understanding, as sought in this study (Johnson et al., 2007).

The research logic in mixed methods research can vary based on how it links theory and empirical observations and which one guides the research (Johnson et al., 2007). Mixed methods research enables using both inductive and deductive logic (Zachariadis et al., 2013). The inductive approach in research aims to develop a new theory from the data whereas deductive approach uses data to test a theory (Johnson & Onwuegubuzie, 2004).

Studies that take the deductive approach test the theory-driven hypothesis within the collected data and try to advance the existing theories. The inductive studies, on the other hand, intrude into the research object with empirical observations and develop theoretical assumptions to explain the phenomenon by creating a new theory or opening new theoretical avenues for further research. Thus, the research process of studies in critical realism applying mixed methods research design often varies between inductive and deductive logic (Zachariadis et al., 2013).

A researcher who follows the mixed methods research approach, aligned with critical realism, often adopts a research logic that is based on abduction (Johnson & Onwuegbuzie, 2004). Abduction allows data-driven research process to be used for theory testing; it also allows the less theory-driven research process to be used for theory development. As abduction is between inductive and deductive research logic, it allows different logic to be used at different phases of the research process, going back and forth between theory and empirical observations, or a researcher may follow abduction throughout the research process (Dubois & Gadde, 2002). Thus, abduction is an appropriate research logic when the ontological, epistemological and methodological considerations reflect the critical realism of the philosophical position of the study (Johnson & Onwuegbuzie, 2004; Järvensivu & Törnroos, 2008; Hodgkinson, 2015). The goal in such research, as in this thesis, often involves increasing the explanatory strength of the existing theory.

3.3 Mixed methods research design

A mixed methods research design allows investigating social contexts and situations by collecting qualitative and quantitative data from multiple sources using different data collection methods (e.g. archives, surveys, interviews and observation) (Bryman & Bell, 2003; Molina-Azorin, 2012). Therefore, mixed methods research design is often employed to study social phenomena that are contextually defined and that their mechanisms are not necessarily empirically observable. Mixed methods research aims to provide descriptions and test or build theories by exploiting the strengths of both qualitative and quantitative research and offsetting each other's weaknesses (Molina-Azorin, 2012). Mixed methods research provides an opportunity for rich descriptions of situations and events in which the phenomenon occurs and, in turn, advances theory development (Starr, 2014); this is a crucial aspect and novelty of this study investigating the strategy frames as a link between the managers, the firms and the environment. In addition, the rich data acquired through multiple methods from multiple data sources enable gaining an in-depth understanding of the phenomenon and constructing theoretical concepts for further analysis and testing (Johnson & Onwuegbuzie, 2004). A mixed methods research design endorses critical methodological pluralism to guide intensive research, which can identify the mechanisms, agencies and social structures generating the behaviour observed (Zachariadis et al., 2013). Generally, a mixed methods research design may combine qualitative and quantitative methods in three ways: (1) a qualitative explorative phase followed by a quantitative phase aiming to generalise the results within the population, (2) conducting a large-scale survey followed by in-depth qualitative data

collection to enrich the findings and (3) utilising both types of methodologies concurrently/cyclically for data analysis where findings from one method can be adjusted using findings from the other (Starr, 2014). These aspects are important particularly for this study since it aims to provide new insights into the concept of the strategy frame. Hence, a mixed methods research design is an appropriate choice for this thesis.

Thus, this thesis investigates the phenomenon of the emergence of differences in cognitive structures across the firms. First, this thesis aims to test a theory by operationalising the concept of dominant logic as a particular form of strategy frame. For this purpose, it applies the theories commonly used in managerial cognition research to mature industry settings in transforming industry conditions. Second, this thesis aims to describe the differences in cognitive structures at different levels of analysis. The overall aim is to advance the theory building of strategy frame and methodological development in managerial cognition research.

Consequently, an important aspect of this study adopting the critical realist assumption of truth is that it can be achieved through observations that are triangulated via multiple methods and multiple data sources (Zachariadis et al., 2013; Turner et al., 2015); this is central to building and testing the theoretical concepts from mixed methods studies and evaluating their generalisability. Often in qualitative research, a theory is seen as emergent in its nature of being local, context-specific and developed by noticing patterns of relationships of constructs and their logical arguments across the data (Starr, 2014). This kind of research, as in this study, represents a cyclical learning process of data, theory development and literature, which seeks answers to a research question arising from an event that evolves and gives rise to new questions and data that can be collected quantitatively, for example, to gain a comprehensive understanding of the phenomenon (Zachariadis et al., 2013). Moreover, a mixed methods research design enables discrete experiments for replications and further development of an emerging theory by generating propositions that are deeply grounded in varied empirical evidence (Wright & Sweeney, 2016). Hence, a mixed methods research design is used to ensure that the systematic and holistic picture of a phenomenon is attained by developing a complete view of and obtaining divergent perspectives of the phenomenon (Zachariadis et al., 2013). Besides, using a mixed methods research design allows one method to compensate for the weaknesses of the other; this comes about by applying an inference from one type of research to another where previous research has already raised new questions for further explanation or development (Zachariadis et al., 2013). Thus, in this study, the truth can be approached by following a mixed methods research design with both qualitative and quantitative methods to investigate the emergence of the differences in cognitive structures across the firms and collect data from multiple data sources.

3.4 Quality of the research

The quality of this study can be evaluated by its reliability and validity. In mixed methods research, the triangulation of data, investigator, theory or methodology is used for different sources of evidence, ensuring the quality of the study (Turner et al., 2015). The

quality of research when using qualitative data is an issue. The observed events are unique, and they are difficult to replicate. Hence, the quality of research can be assured by following the research protocol of the selected approach, that is the protocol of the cognitive mapping method as in this study. However, in qualitative research, research trustworthiness is an essential measure of validity and reliability (Bryman & Bell, 2003; Zachariadis et al., 2013). Trustworthiness has four key components, namely creditability, transferability, dependability and confirmability (Miles & Huberman, 1994).

Credibility concerns confidence in the truthfulness of the findings (Miles & Huberman, 1994). An important way to increase credibility is to achieve triangulation by using multiple data sources, multiple investigators, different theoretical perspectives and different methods (Denzin, 1978; Johnson & Onwuegubuzie, 2004). First, all the publications presented in this these were co-authored, and in this sense, the research was triangulated by multiple investigators. Second, the study used multiple data sources to investigate the topic; these included quantitative and qualitative data as well as data from various firms, countries and longitudinal data. In some cases, methodological triangulation is achieved by collecting data from two different perspectives, namely schema theory and social construction view of the industry when interpreting the data from multiple sources. Besides, the results have been presented in academic conferences and workshops, and feedback from other researchers was gained through the double-blind review process for academic journals and blind reviews for conference papers.

Transferability refers to the applicability of the findings to other contexts (Miles & Huberman, 1994; Zachariadis et al., 2013). The findings are derived from the data from different industries and case firms: *Publication 1* from a magazine industry, *Publication 2* from the transportation industry and *Publications 3–5* from the cleantech industry. In this sense, the results may be transferrable to different contexts.

Dependability concerns the extent to which the findings are consistent and can be replicated (Miles & Huber, 1994). In this study, the research design and implementation were clearly explained in the publications, allowing the thesis' consistency to be evaluated.

Confirmability deals with the degree of research neutrality and objectivity by considering how well the research avoids researcher bias and interests (Miles & Huberman, 1994). In this study, research confirmability was achieved through multiple types of triangulation, use of direct cognitive map quotations in some publications and explaining the data collection and analysis clearly and transparently.

3.5 Data collection and analysis

The mixed methods research design of this study includes three main data collection phases and different data analysis methods. *In the first phase*, *Publication 1* focuses on collecting and analysing quantitative data. *In the second phase*, *Publications 2*, *3* and *4* use cognitive mapping with distance ratio for collecting and analysing the data. *In the*

third phase, the annual reports of the firms over nine years were collected and analysed using quantitative thematic analysis approach in *Publication 5*.

In all three phases, the selection of the data sources is tightly aligned with the research aims and questions, which involve collecting in-depth data from multiple sources for a holistic understanding of the phenomenon under scrutiny. Due to the nature of the mixed methods research, the investigated objects varied from a unique contemporary event (shared cognitive structure of the board) to a historical well-documented phenomenon (development of the strategy frames of the cleantech firms over the years); thus, multiple criteria were considered for selecting the research objects. First, the research objects should be representative so that they can reflect the phenomenon being studied; they should also provide rich qualitative and quantitative data (Turner et al., 2015). The research objects should create opportunities to develop theoretical concepts for further testing, extend theory and allow the replication of previous studies as well as the transparent observation of the phenomenon (Stake, 2001; Wright & Sweeney, 2016). An important aspect of selecting research objects is the validity of the potential data; in this study, for example, multiple data sources and analysis methods allow triangulating and strengthening the research and validating the results (Turner et al., 2015). As in this thesis, triangulation can be achieved through data, investigator, theory and methodological triangulation (Bryman & Bell, 2003).

The first phase

Data collection

In this phase, the data were collected to explore the interaction between the dominant logic of the firm and the firm's innovation activities by linking interaction with firm performance. Besides, the data served the operationalisation of the theoretical concept of dominant logic. In strategic management research, a few studies have measured and developed the concept of dominant logic introduced by Bettis & Prahalad (1986) at the firm level (e.g. Kor & Mesko, 2013; Maijanen-Kyläheiko, 2014), which posed a challenge to this study.

The empirical data for this purpose were collected through a web-based survey instrument from the consumer magazines in Finland, Sweden and Russia during 2012 (Jantunen et al., 2012). The respondents were editors-in-chief, who were considered the top managers of the firms. The survey questionnaire with a cover letter was sent to 579 respondents, and a total of 103 usable responses were received, yielding a response rate of 18%. Even though the response rate can be considered satisfactory and typical for innovation management surveys, the sample size for each country was small because of the small population of each country. As a result, the three data sets were pooled together.

Data analysis

In *Publication 1*, the data were used to test the argument that dominant logic and innovation activities do not have a direct, independent impact on business performance, although their interaction does. This was discovered when the regression model was fitted to the data where we predicted organisational performance using the Classical linear regression model. Specifically, hierarchical multiple regression analysis for testing was applied, and the main argument was assessed by estimating the regression model in three stages: (1) base model with no predictors but only the country dummy variables in the model, (2) the main effects of dominant logic variables and innovation activity variables added to the model, and (3) interaction of dominant logic variables and innovation activity variables added to the model. In the model, several variables were used to ensure the solidity of the argument. In this analysis, adding the interaction terms to the model (in Phase 3) caused a significant increase in the proportion of variance, explained in the organisational performance. The analysis of data and results are discussed and summarised in Chapter 5.

Hence, the study allowed comparing the role of dominant logic in different types of organisational innovation activities and measuring its effects on firm performance; in this sense, the study helped advance the concept of dominant logic. The data collection and analysis process with the results are reported in detail in *Publication 1*.

The second phase

Data collection

In the second phase of the study, the empirical data were collected from 2012–2015 using the cognitive mapping method from several firms in Finland (Appendix 1). The studied firms were selected to fulfil the mixed methods research criteria and provide access to different levels of analysis of cognitive structures across the firms. In *Publications 3* and *4*, the firms operated in both fast- and slow-changing industry sectors within the cleantech industry. In *Publication 2*, the firm represents the slow-changing industry. They were also expected to have a clear management structure, including a board of directors, top management and middle management in each firm. Besides, this thesis included some additional criteria for the publications, for example, to provide evidence of the existence of the theoretical concept of dominant logic at different organisational levels as in *Publication 2*. The suitability of the case firms was assessed by examining the web pages and annual reports of the firms to ensure that they represented different types of firms with different business networks (e.g. SMEs, large firms and incumbents). The final selection of the cases was made based on personal knowledge of the firms' backgrounds and after discussion with the firm representatives (i.e. the firm's managing director); the discussion also supported the commitment of the firms to the research.

In *Publications 2*, *3* and *4*, the data collection and analysis process followed the same primary approach, based on the hybrid cognitive mapping method (e.g. Axelrod, 1976; Eden, 2004; Hodgkinson et al., 2004; Tyler & Gnyawali, 2009) shown in Figure 2.

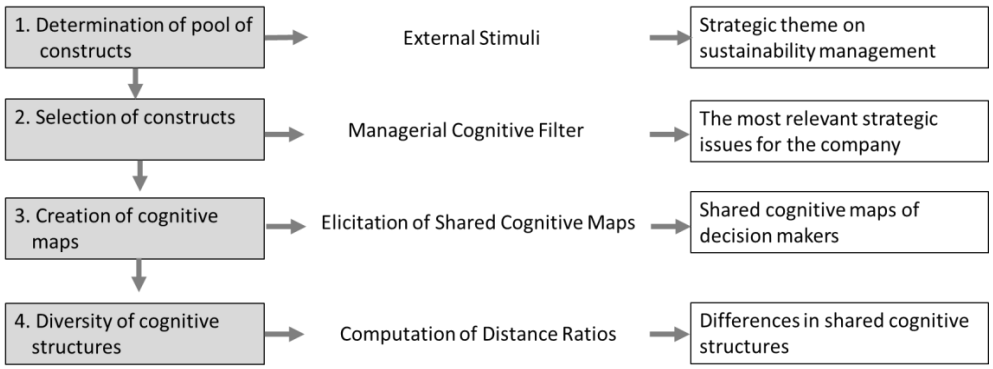

Figure 2. The main phases in the elicitation and analysis process of cognitive maps (Bergman et al., 2020).

In Publication 2, the focus was on analysing the differences in cognitive structures between different organisational levels (i.e. at the top and middle management levels). The selection of the firm for data collection, the firm size and the maturity of the industry were essential criteria for obtaining the required data for analysis. To select the case firm, this study followed the criterion of large firms operating in slow-changing industry conditions used by Nadkarni & Narayanan (2007a, b). The selected multinational firm operates in the transportation sector, providing services to commercial clients and the government for over 150 years (Appendix 2). It is a public listed company and has a dominating position in the national market. The top managers' group comprised 39 top management executives, and the middle managers' group was composed of 38 managers. Altogether, the study provided 75 cognitive maps as two maps were unreadable and hence could not be used. The study was conducted as a class requirement during the training courses attended by the respondents at a Swedish University Business School. To respond to the survey, the managers received and conducted the cognitive mapping exercise individually in the classroom during the training session.

Thus, the empirical data (i.e. the cognitive maps) were collected from a large transportation firm using the hybrid cognitive mapping method, following the process shown in Figure 2. In the study, the top and middle managers evaluated the sustainability issues separately, and their relevance to the firm provided 75 individual cognitive maps. The data were collected during the corporate designed MBA programme in winter of 2015.

In *Publications 3* and *4*, the case firms were selected by focusing on cognitive diversity at different levels of analysis among the firms operating in the emerging cleantech industry. The selected firms represented different business sectors within the industry, displaying cognitive diversity between them. The sample aimed to provide examples of different types of board composition to recognise the differences in the key theoretical cognitive concepts and the logic of the phenomenon at different levels of analysis; the sample also aimed to advance the methodology development in managerial cognition research.

The empirical data (i.e. the cognitive maps) were collected from 2012–2013. As the study was exploratory, the individual cognitive maps were collected through a survey from the boards of nine firms operating in the cleantech industry in Finland. To elicit the cognitive maps, the study used the hybrid cognitive mapping method introduced above. From the nine selected firms, one was a publicly owned regional energy generation and distribution firm (A), one was an investor-owned energy generation firm (E) operating in Nordic countries, three were original equipment manufacturer firms in the energy and related business (B, F, H), three were component manufacturing firms (D, C, G) operating globally and one was a financial service firm (I). All the firms had been gaining a significant share of their turnover from cleantech industry operations (Appendix 2). The number of respondents varied from three to seven directors in the firms, resulting in 43 respondents altogether.

Data analysis

Publications 2, *3*, and *4* applied different perspectives for the analysis of the data using direct and indirect measures for cognitive structures collectively or separately (Hambrick & Mason, 1984; Kilduff et al., 2000; Tyler & Gnyawali, 2009). As a method, this study combined nomothetic and ideographic causal mapping techniques, known as hybrid cognitive mapping method, for data collection and elicitation of managerial cognitive maps with the cognitive diversity measure (Axelrod, 1976; Langfield-Wirth & Smith, 1992; Eden, 2004; Hodgkinson et al., 2004; Tyler & Gnyawali, 2009; Schraven et al., 2015).

In *Publication 2*, for analysing the created cognitive maps and measure the cognitive diversity of the cognitive structures at different levels of analysis, the hybrid cognitive mapping method with distance ratio were used. The diversity of the shared cognitive maps was analysed using the distance ratio LSW formula 12 (Langfield-Wirth & Smith (1992) formula 12) (Eq. 1). The analysis of the cognitive maps with distance ratio revealed the differences between the top and middle management cognitive structures and increased the understanding of the existence of dominant logic as the strategy frame of the firm at different organisational levels. Besides, the aim was to advance the managerial cognition methodology for the comprehensive analysis of the cognitive structures at different organisational levels. The analysis of the data and the results are discussed and summarised in Chapter 5.

In *Publication 3*, for analysing the created cognitive maps by measuring cognitive diversity and content of the cognitive structures at different levels of analysis, the distance ratio formula (Markoczy & Goldberg, 1995) (Eq. 2) and the graph analysis method with eigenvector (Eq. 4), used to measure the centrality of the strategic issues in the maps, were used. The analysis of the data allowed examining the role of cognitive diversity in perceiving strategic issues by the boards of directors. In addition, this publication pursued the goal of advancing managerial cognition methodology by further developing the method for the comprehensive analysis of decision-makers' cognitive structures. The analysis of the data and the results are discussed and summarised in Chapter 5.

In *Publication 4*, the same data as *Publication 3* were used for analysis. The aim was to investigate the collected data to find out the link between cognitive diversity, managerial demographics and firm outcomes using measures of sales and profitability as an indication of firms' financial performance (Venkatraman & Ramanujan, 1987; von Krogh et al., 2000). For this purpose, the original LSW formula 12 (Eq. 1) was further developed for the analysis of the cognitive maps by adding the area information of the maps to the formula (Eq. 3). To analyse the created cognitive maps and measure cognitive diversity among the participants of the study, first, the study used the original LSW formula 12 (Langfield-Smith & Wirth, 1992), and next the LSW formula was modified for computing the non-metric distance ratios for each board member and aggregating them into firm and industry levels. Finally, the analysis of the cognitive diversity was linked with the managers' demographic characteristics (Hambrick & Mason, 1984), and consequently, these results were linked with the financial data collected from 2012–2016. The analysis of the data and the results are discussed and summarised in Chapter 5.

The original Langfield-Smith and Wirth's (1992) formula 12.

$$DR = \frac{\sum_{i=1}^{p}\sum_{j=1}^{p}\left|a_{ij}^{*}-b_{ij}^{*}\right|}{6pc^{2}+2pc(pu_1+pu_2)+pu_1^{2}+pu_2^{2}-(6pc+pu_1+pu_2)} \quad \text{(Eq. 1)}$$

where

$$a_{ij}^{*}=\begin{cases}1 & if\ \ a_{ij}>0\ and\ i\ or\ j\ \notin Pc\\ -1 & if\ \ a_{ij}>0\ and\ i\ or\ j\ \notin Pc\\ a_{ij} & otherwise\end{cases}$$

P is total number of possible nodes, Pc is the set of nodes common to both maps, p_c is the number of such nodes, pu_A is the number of nodes unique to map A and pu_B is the number of nodes unique to B. a_{ij} is the value of the ith row jth column in the extended association matrix M. This formula is commonly referred as LSW formula 12 (Langfield-Smith and Wirth, 1992).

Markoczy and Goldberg formula (1995).

$$DR\ \ (A,B) = \frac{\sum_{i=1}^{p}\sum_{j}^{p} diff(i,j)}{(\epsilon\beta+\delta)p_c^2+\gamma'(2p_c(pu_1+pu_2)+pu_1^2+pu_2^2)-\alpha((\epsilon\beta+\delta)p_c+\gamma'(pu_1+pu_2))} \qquad \text{(Eq. 2)}$$

where

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

and

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

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 maps *A* and *B*. $\alpha, \beta, \gamma, \delta, \varepsilon$ are the parameters described in Markoczy and Goldberg (1995).

The original LSW formula 12 developed further by the researchers of this study to utilise more information available in the cognitive maps.

The graphically presented cognitive map has a two-dimensional form, describing the area of the map. In turn, the area of the matrix is the sum of the cells ($\hat{a}_{ij}$), where the area of a single shell equals $\hat{a}_{ij} = 1$. In this sense, non-empty shells of the association matrix describe the area of the cognitive map. Hence, the area of a cognitive map can be presented as $A = \sum_{i=1}^{p}\sum_{j=1}^{p}\hat{a}_{ij}$.

$$DR\ \ = \frac{\sum_{i=1}^{p}\sum_{j}^{p}\left|a_{ij}^{*}-b_{ij}^{*}\right|+|A_a-A_b|}{6pc^2+2pc(pu_1+pu_2)+pu_1^2+pu_2^2-(6pc+pu_1+pu_2)+\max(A_a,A_b)} \qquad \text{(Eq. 3)}$$

where

$$a_{ij}^{*} = \begin{cases} 1 & if\ \ a_{ij}>0\ and\ i\ or\ j\ \notin Pc \\ -1 & if\ \ a_{ij}>0\ and\ i\ or\ j\ \notin Pc \\ a_{ij} & otherwise \end{cases}$$

Here, instead of ratio, computing the absolute value of the difference of the areas and scale it by using the maximum area to ensure that DR does not exceed value 1. Now, examining reflexivity and symmetricity, it can be seen that $|A_a - A_a| = 0$ and $|A_a - A_b| = |A_b - A_a|$, and this way, Equation (3) preserves both properties. Similarly, the added maximum in the denominator preserves these properties and also ensures that DR ϵ [0,1]. Thus, Equations (1) and (3) can be used to compute distance ratios for each map in comparison to the shared cognitive map of a group or wider population (i.e. with the extended association matrices).

The centrality analysis taking into consideration the relative importance of the nodes in the cognitive maps computing eigenvector centrality measures for a given node.

$$x_i = \frac{1}{\lambda}\sum_{j=1}^{n} A_{ij}x_j \ , \qquad \text{(Eq. 4)}$$

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

$$\lambda x = A \cdot x \ ,$$

where x is an eigenvector of the association matrix with eigenvalue λ. In the formula, 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.

The third phase: Analysis of the annual reports in 2009–2016

The longitudinal data collected from the annual reports were used in *Publication 5* to create a holistic understanding of the existence of the collective strategy frame among the fast-developing cleantech industry firms. Following the earlier study (Nadkarni & Narayanan, 2007a), the incumbent firms were considered drivers of the industry-level change in the strategy frames, and therefore, were selected as data sources.

In *Publication 5*, the firms' annual reports served as a mean to capture the attributes of top managers' beliefs, investigating the interplay between the strategy frames and the competitive environment (e.g. Barr et al., 1992; Nadkarni Narayanan, 2007b; Kaplan, 2008; Kiss & Barr, 2015). Annual reports are seen as key tools for top managers to communicate with the firms' stakeholders even if managers may have a limited practical role in preparing them (Barr, 1922; Fiol, 195). In this study, the focus was on the firms' mission and vision presented in the annual reports, as reflections of the top managers' future beliefs embedded in the strategy frames. Mission and vision are strategic statements that express the fundamental purpose of the firm and the future it seeks to create (Bart & Baetz, 1998; Laitinen & Meristö, 2016).

Data collection

Data for the analysis were collected during spring 2018 from the annual reports of each firm over eight years (2009–2016). From the firms' annual reports, the mission and vision statements were extracted into a single text file for content analysis. The final sample of the firms covered 66 incumbent firms, traded in OMX Nasdaq Nordic Helsinki, and Stockholm stock exchange, including three non-traded firms that had an active role in the Finnish cleantech industry. The selected firms had their headquarters or a significant share of the firm's operations in Finland, and the annual reports clearly expressed that they were focused on environmentally friendly technologies and services in their businesses. The final criterion for the selection was that the firms were expected to have been traded in 2009–2016 stock exchange for covering the research period.

Data analysis

From the firms' annual reports, the mission and vision statements were extracted into a single text file for content analysis. The mechanism for the analysis builds on advanced text analytics techniques and accordingly a software toolkit which facilitated the text extraction and coding of the textual content (Blitzer, 2007). The procedure for the retrieval and quantitative data analysis of the firms' mission and vision textual contents is shown in Figure 3.

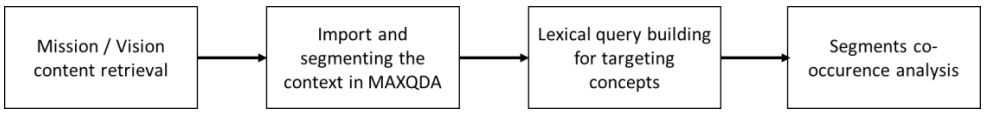

Figure 3. The main steps of the analysis process of the study.

The contextual analysis of the annual reports was conducted using the terminology developed in the related literature and the analysis of 20 annual reports, for example 'green energy, recycling society, life-cycle, online service, robotic, waste management, distributed energy systems, IoT, smart energy, resource efficiency, big data, IT, ICT'. The list of the terms representing the cognitive constructs used in the annual reports was divided into three wider categories: 'Renewable Energy, Sustainability, and Digitalization', to detect and illustrate the development patterns of the interrelating technology areas among the sample firms. The detected coded segments were later utilised to specify the overlapping coded segments to indicate the year and the part of the mission and vision concepts that displayed the development patterns of the collective cognitive frame. The analysis of the data and the results are discussed and summarised in Section 5.

The research process and the relationships of the research questions, data collection and publications conducted during the study are summarised in Figure 4.

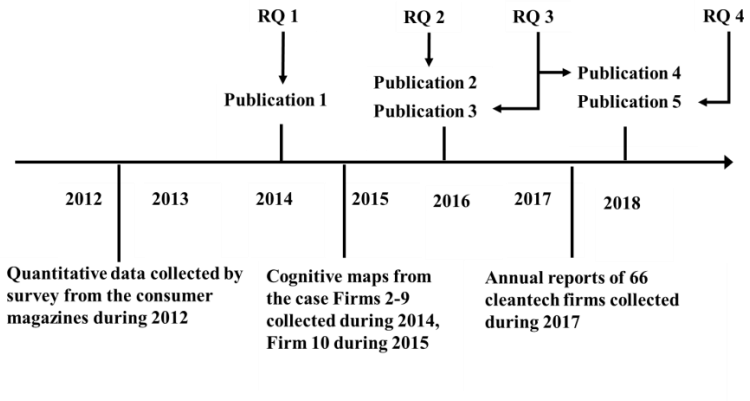

Figure 4. Research questions, data collection and publications.

The data collection, analysis, and results are discussed in more detail in the following Chapter 5 when summarizing the Publications of this study.

4 Framework of the study

This study comprises five separate publications that investigate the phenomenon of the interconnection between the top managers, the firms and the industry via managerial cognitive structures and its organisational implications. The publications are interconnected, providing the answers to the main RQ and the four SQs presented in Section 1.5. Figure 5 shows the relationships between the publications, methodologies, the main theoretical concepts and the levels of analysis.

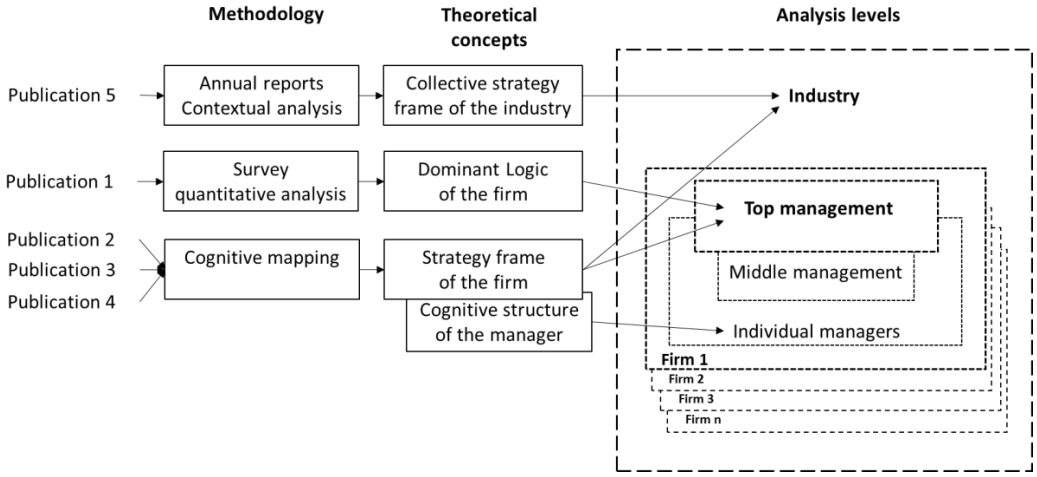

Figure 5. The framework of the study.

In the next chapter, the key objectives, data collection and analysis, key findings and the main contributions to the literature and the thesis of each publication are summarised. Then the conclusions and the contribution of the thesis and the future research avenues are discussed.

5 Summary of the publications

5.1 Publication I

Managerial cognition and dominant logic in innovation management: Empirical study in media industry

Objectives

The study analysed the organisational innovation activities involving social and cognitive aspects within the dominant logic of the firm. Top managers' shared cognitive structures store the dominant logic of the firm, which directs strategic organisational activities (e.g. innovation activities). The main objective of the study was to investigate the complicated relationship between dominant logic and innovation activities and its impact on business performance by operationalising the concept of dominant logic within the transforming print media industry firms.

Data collection

The empirical data on the complicated relationship between dominant logic, firm activities and firm performance were collected through a web-based survey instrument from the Consumer Magazines in Finland, Sweden and Russia during 2012. The questionnaire items were developed based on the relevant literature, and qualitative interviews with the editors-in-chief, as key informants/decision-makers of the firm, were included in the study (Jantunen et al., 2012). The respondents were editors-in-chief representing the top managers of the firm. The survey questionnaire with a cover letter was sent to 579 respondents, and 103 usable responses were received, yielding a response rate of 18%. Although the response rates can be perceived as satisfactory and typical for innovation management surveys, the sample size for each country was small due to the small population of each country. Thus, the three data sets were combined.

Data analysis

In the study, the variables for measuring whether the dominant logic of the firm was externally or internally oriented were used to describe the extent of strategic importance of (1) external stakeholders as competitors or consumers, advertisers and value-network partners and (2) internal assets as media content or media product (see von Krogh et al., 2000). For measuring exploitative and explorative innovation activities (March, 1991; Kuittinen et al., 2013), the respondents were asked to (a) indicate the extent to which they had made different renewals during the past two years and (b) evaluate how commercially significant the different renewals made had been. For measuring these two types of innovation activities, the first factor 'exploitation' was selected because the renewals in question concerned making changes to traditional revenue logic of a consumer magazine, such as improvement of printed product, practices, leadership and human resource management The second factor was labelled 'exploration' mainly because the renewals concerning this factor dealt with new revenue logic, such as new digital products and

product portfolios, distribution, new target markets and technology. For measuring firm performance, profitability, turnover from new products and customer satisfaction were used as single-item measures whereas the rest of the measures were subjected to exploratory factor analysis.

Thus, the data in *Publication 1* were used to test the argument that dominant logic and innovation activities do not have a direct, independent impact on business performance, although their interaction does. This argument was discovered when the regression model was fitted to the data where the study predicted organisational performance using OLS. Hierarchical multiple regression analysis for testing was specifically applied, and the main argument was assessed by estimating the regression model in three stages. First, the base model with no predictors, second, the main effects of dominant logic variables and innovation activity variables, and finally, interaction of dominant logic variables and innovation activity variables were added to the model. In the final third phase of the model adding the interaction terms to the model, the analysis enabled to explain the organisational performance. As required, in the model, several variables were used to assure the solidity of the argument. Hence, the study enabled comparing the role of dominant logic in different types of organisational innovation activities and measuring its effects on firm performance to advance the concept of dominant logic.

Findings

The study confirmed the argument that dominant logic and innovation activities do not have a direct, independent impact on business performance, although their interaction does. The key findings show that the firms' dominant logic influences their strategic activities and has a central role in firm-level business performance. They especially show how the shared managerial cognition effects on innovation activities, namely explorative and exploitative, and further on firm-level innovation outcomes. The empirical findings show that three of the five performance measures, namely turnover from new products, customer satisfaction and market performance of the print product, were influenced by dominant logic. Thus, the study illustrates the interaction between the general dominant logic of the firm and innovation activities, revealing a clear impact of the top managers' (chief editors') shared cognition on strategic activities (i.e. innovation activities). Besides, the study found some evidence of congruence between dominant logic and organisational path dependence. These notions were supported by the findings related to the explorative, innovative activities, showing that the investments in new technology do not play a central role in immediate higher performance.

Main contribution

The findings of the study contribute to the literature on managerial cognition research, especially the research on dominant logic as the top managers' shared cognitive structure and the literature on transforming industries driven by digital technology. The findings provide evidence of the effects of dominant logic of the firm on the firm's activities and firm-level outcomes. Besides, the findings of the study contribute to the innovation

management literature by increasing our understanding of the role of managerial cognition in shaping the innovation activities within organisations.

As for this thesis, the study focuses on the first research question concerning the concept of dominant logic and its relationship with firm performance. The study operationalises the concept of dominant logic further to deepen our understanding of the intertwined relationship between dominant logic, firm's activities and performance. Overall, the study contributes to the dominant logic literature by advancing our understanding of its organisational effects and conceptual development.

5.2 Publication II

Information processing approach in organisational cognitive structures: Relationship between top and middle managers' cognitions

Objectives

The research objective was to examine the existence of cognitive structures at two organisational levels within a single organisation by investigating cognitive diversity. This study took the information processing approach in managerial cognition research, assuming that top managers communicate their shared beliefs of the business environment to the organisation by reducing the ambiguity of operative environment faced by the other levels of the organisation, thus shaping the cognitive activities of the organisation. Therefore, the key aim was to analyse top managers' cognitive diversity and middle managers' cognitive structures and understand the differences between the top and middle managers' shared cognitive structures. In addition, by utilising cognitive mapping with diversity ratio, the study aimed to advance a methodology in measuring where dominant logic becomes apparent as a shared cognitive structure at different organisational levels.

Data collection

In this study, the managers made sense of the sustainability issues and developed personal cognitive maps for the examination of the shared cognitive structures and their differences at two management levels, namely top and middle. The managers worked in a large multinational public listed company firm operating in the transportation sector, providing services for commercial clients and the government. For data collection and elicitation of the cognitive maps, this study combined nomothetic and ideographic causal mapping techniques, known as hybrid cognitive mapping method (Laukkanen, 1990; Axelrod, 1976; Eden, 2004; Hodgkinson et al., 2004; Tyler & Gnyawali, 2009). This method allows exploring individual cognitions in different contexts (Bougon, 1992; Laukkanen, 1998; Hodgkinson et al., 2004) and enables an inductive and deductive analysis of strategic issues for a specific purpose and context (Clarke & Mackaness, 2001). The top managers' group was composed of 39 top management executives, and the middle managers' group comprised 38 managers. Altogether, the study provided 75 cognitive maps; two maps were unreadable and thus dismissed. The study was conducted as a class

requirement during the training courses attended by the respondents at a Swedish University Business School in 2015. The managers received and conducted the cognitive mapping exercise individually in the classroom during the training session. The exercise is described in Appendix 1.

Data analysis

To analyse the created cognitive maps and measure cognitive diversity of the cognitive structures at different levels of analysis, the LSW formula 12 (Langfield-Smith & Wirth, 1992) (Eq. 2) was used for computing the non-metric distance ratios for each respondent and aggregating the maps into different organisational levels, namely top and middle management levels. The formula was presented in Section 3.5. The main phases in the elicitation and analysis process of the cognitive maps are shown in Figure 2 (see Section 3.5).

First, the content of the cognitive maps was examined by creating the frequency analysis to identify the most relevant cognitive concepts in the maps. This phase revealed the similarities in the interpretative patterns between the top and middle management. Next, the differences between the top and middle managers' cognitive structures were examined by calculating the non-metric distance ratios for each manager. The individual cognitive maps were aggregated into the top and middle management levels and analysed as individual cognitive maps. Differences in cognitive diversity were measured by investigating the degree of distance ratios to understand whether the degree was higher among the top or middle managers. When analysing group-level cognitive structures, the mean distances illustrate the degree of diversity of the cognitive structures (Markoczy & Goldberg, 1995) and reveal the linkage between the top and middle managers' shared cognitive structures. The analysis results show that the top managers' mean distance was higher than that of the middle managers, meaning that top managers' cognitive structure is more diversified than that of the middle managers. Finally, the interpretation of the results was based on the assumption that if the degree were lower in the middle management group, then it would be possible to assume that the top managers' cognitive structure gave frames for the middle managers' information space and restricted the cognitive activities in the firm (Beck & Plowman, 2009; Schraven et al., 2015).

Findings

The study provides evidence of similarities in cognitive patterns between the top and middle managers. First, the findings show that the middle managers pay attention to the same strategic issues as the top managers, suggesting similarity in the interpretative patterns. Second, the findings show that the areas of the top managers' cognitive maps are broader than those of the middle managers' cognitive maps. Third, based on the assumption that the degree of diversity would be lower in the middle management group, the results are able to interpret so that they indicate that the top managers' cognitive structure provides frames for the middle managers' information space. This way, the cognitive structure of the top management is assimilated into the cognitive structures of

middle management (Beck & Plowman, 2009; Schraven et al., 2015). Finally, regarding the analysis of dominant logic as a shared cognitive structure, the findings demonstrate the applicability of the hybrid cognitive mapping method with distance ratio for measuring dominant logic at different levels of the organisation.

Main contribution

Overall, the study contributes to the literature on managerial cognition research by investigating the concept of dominant logic as a shared cognitive structure of the top managers. The findings contribute to the problem of operationalisation of dominant logic by using distance ratio computed with LWS formula 12 to analyse the cognitive diversity of the shared cognitive structures at the top and middle management levels. Next, the findings of the study contribute to research on managerial cognitive structures, proving cognitive maps with distance ratio as a measure for cognitive diversity in the analysis of cognitive structures at different levels of analysis.

As for this thesis, the study mainly focuses on the second sub-question concerning differences between the shared cognitive structures at different organisational levels. Thus, the findings contribute to the literature on the managerial cognition, particularly the strategy frames studies by providing a quantitative measure to compare shared cognitive structures at different organisational levels. Thus, the study increases our understanding of dominant logic as a shared cognitive structure directing the cognitive activities in the firm. Besides, the study provides an approach to investigate comprehensively managerial cognitive structures by eliciting, aggregating and analysing cognitive maps at different organisational levels.

5.3 Publication III

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

Objectives

The main objective of the study was to examine the cognitive structures across the firms' key decision-makers making sense of sustainability issues. For this purpose, the study investigated cognitive diversity and centrality of cognitive concepts to identify common cognitive patterns in shared cognitive structures at different levels of analysis across the cleantech industry firms. Another objective was to advance the quantitative methods for the analysis of decision-makers' cognitive structures at different levels of analysis.

Data collection

For data collection and the elicitation of the decision-makers' cognitive maps, the nomothetic and ideographic causal mapping techniques, known as hybrid cognitive mapping, was used (e.g. Axelrod, 1976; Bougon, 1992; Eden & Ackermann, 1992; Langfield-Smith & Wirth, 1992; Hodgkinson et al., 2004). The empirical data (i.e.

cognitive maps) were collected from the case firms (Appendix 2) through a survey from 2012–2013, as described in Section 3.5. The sample comprised 43 individual cognitive maps collected from the boards of nine firms operating in the cleantech industry in Finland. The method allows exploring individual cognitions at different contexts (Bougon, 1992; Hodgkinson et al., 2004) and enables inductive and deductive analyses of strategic issues for a specific purpose and context (Clarke & Mackaness, 2001).

Data analysis

The analysis followed the main phases of the analysis process of the cognitive maps, shown in Figure 2 of Section 3.5. First, the content of the cognitive maps was analysed using the frequency analysis for the cognitive concepts of sustainability occurring in the maps. The analysis shows the relevance of the strategic issues for the firms. The economic issues were dominating the decision-makers' interpretations across all the firms. Second, for the analysis of cognitive diversity across the firms, Markoczy & Goldberg's (1995) formula (Eq. 3) was used for computing the non-metric distance ratios as an indicator of the similarities of the cognitive maps. First, the differences in the cognitive structures were examined by calculating the non-metric distance ratios for each manager. Then the individual cognitive maps were aggregated into the firm and industry levels and analysed as individual cognitive maps. The formula (Eq. 3) was presented in Section 3.5. Based on the distance ratios, the firms were ranked by comparing the firms to the industry-level cognitive maps. Third, the content of the cognitive maps was analysed. For this purpose, the contextual analysis was conducted for the created firm and industry-level shared cognitive maps, using the graph analysis method with the eigenvector centrality measure (Eq. 4) (Bonacich, 2007; Knoke et al., 2008; Abraham & Hassanien, 2010). The analysis shows the most central issues for the firms and the industry and enables ranking the issues according to their centrality in the shared cognitive maps. For identifying the similarities in the interpretative patterns among the firms, the Spearman's rank correlation coefficient (ρ) was subsequently applied to the ranked strategic issues based on the centrality. The Spearman's rank ρ shows the correlations between the firms and how they interpret the strategic issues compared to each other. The Spearman's rank ρ was also computed at the industry level to compare the firms' interpretations to those of the industry level. Finally, the relationship between cognitive diversity and the centrality of the issues was analysed at the industry level. For this purpose, the correlation analysis between the firm rankings derived from the industry-level cognitive diversity ratios and the Spearman's rank correlation of strategic issue interpretations was conducted. This analysis shows the relationship between the cognitive diversity of the decision-makers' shared cognitive structures and the strategic issues of interpretation at the industry level, that is the interpretation of sustainability issues within the cleantech industry.

Findings

The findings of the study show the differences within and between the shared cognitive structures across the cleantech industry firms. By analysing the cognitive maps among the firms, the study identifies strong common patterns of interpretation of the strategic

issues across them. The firms emphasised economic issues compared to environmental and social issues. Regarding the similarities of the cognitive patterns, the findings show significant correlations between the firms' interpretations of the strategic issues and the cognitive diversity of the firms at the industry level. Besides, although the research settings focus on sustainability management, the study shows that sustainability management issues had received limited attention from the decision-makers in the cleantech industry firms.

Main contribution

The study contributes to the literature on managerial cognition research, especially strategy frame research by investigating differences in the managerial cognitive structures within the cleantech industry. The findings contribute to the research methodology by combing two quantitative analysis methods for the cognitive maps using the two direct cognitive measures, distance ratio and centrality measures to identify the cognitive patterns across the firms operating in the industry.

As for this thesis, the study focuses on the third sub-question concerning the relationship between cognitive diversity and decision-makers' interpretations. By analysing cognitive structures at different levels of analysis, the findings reveal the relationship between the firms' cognitive diversity and the industry-level interpretation of the strategic issues. Consequently, the study contributes to the development of the managerial cognition research methods, using the hybrid cognitive mapping method for collecting decision-makers' cognitive maps and aggregating them into different levels for analysis with cognitive diversity and centrality measures. Thus, the study increases our understanding of the analysis of cognitive structures at individual group, firm and industry levels.

5.4 Publication IV

Cognitive diversity, managerial characteristics and performance differences across the cleantech firms

Objectives

The overall objective of the study was to analyse managerial cognitive structures at different levels of analysis at individual, firm and industry levels, providing insights into the relationship between cognitive diversity, decision-makers' demographics and firm performance. Besides, the study further develops and operationalises the distance ratio as a measure for the analysis of the managerial cognitive maps to utilise more information available in the cognitive maps.

Data collection

In this study, the firms' decision-makers' cognitive structures were examined utilising both direct and indirect measures (Hambrick & Mason, 1984; Kilduff et al., 2000); Tyler & Gnyawali, 2009). For this purpose, the cognitive mapping technique with the distance ratio calculated from the cognitive maps as direct cognitive measure and the demographic characteristics as indirect cognitive measures were used. By analysing the linkage between cognitive diversity and firm outcomes, the measures of sales and profitability were used as an indication of the firms' financial performance (Venkatraman & Ramanujan, 1987); von Krogh et al., 2000).

For data collection and the elicitation of the decision-makers' cognitive maps, the nomothetic and ideographic causal mapping techniques were combined and used (e.g. Axelrod, 1976; Bougon, 1992; Eden & Ackermann, 1992; Langfield-Smith & Wirth, 1992; Hodgkinson et al., 2004). The empirical data, the cognitive maps and the respondents' demographic background information were collected from the case firms through a survey from 2012–2013, as described in Section 3.5. The sample comprised 43 individual cognitive maps collected from the boards of nine firms operating in the cleantech industry in Finland. The firms' financial data (sales and net profit) were collected from the annual reports published between 2012 and 2016, using the Voitto+ database.

Data analysis

First, for analysing the created cognitive maps and measuring cognitive diversity among the participants of the study, the original LSW formula 12 (Langfield-Smith & Wirth, 1992) was used. The analysis was conducted at the individual, firm and industry levels. Second, the LSW formula 12 (Eq. 1) was modified by the researchers of the study. The area information was incorporated into the formula (Eq. 2), and the non-metric distance ratios for each board member was computed. Next, the cognitive maps were aggregated into the firm and industry levels and analysed as individual cognitive maps. The results of both formulas were compared by ranking the firms. The formulas (i.e. Eq. 1 and Eq. 2) were described in Section 3.5. Third, the respondents' demographic information was analysed to identify the demographic composition of the boards. Next, the relationship between the demographic compositions and cognitive diversity of the boards was investigated using the correlation analysis method. Finally, these results were interpreted with the financial data of the firms collected through the years 2012–2016.

Findings

The findings of the study show that the decision-makers' board tenure, industry experience and age explain the cognitive differences between the firms in the aggregated cognitive map in industry level. The findings of the study also show that the demographic composition of a decision-making group stressing economic expertise creates higher-level cognitive diversity compared to technical expertise. The findings did not find any

significant combined effect of the demographic composition on the decision-making groups and the cognitive diversity explaining the volatility of the financial outcomes of the firms. Thus, the relationship between cognitive diversity, demographic characteristics and financial performance among cleantech firms can only make interpretative assumptions on inductive bases. For example, the experience gained over time may have a balancing effect on cognitive diversity and financial performance development among cleantech firms.

Next, the findings of the study advance the quantitative analysis of the managerial cognitive maps by operationalising and developing the original Langfield-Smith and Wirth's (1992) formula 12 to consider more information available in the cognitive maps. The findings demonstrate that, as in this study, variations in distance ratios between the cognitive maps increase when the area information is taken into account in the analysis. By comparing the rankings of the firms at different analysis levels based on the distance ratios computed by the formulas (i.e. Eq. 1 and Eq. 2), the firms take different positions in the ranking continuum.

Thus, the findings show that analysing the managerial cognitive maps using both direct and indirect cognitive measures helps one better explain the diversity of the cognitive structures and firm performance differences across the firms than using them separately.

Main contribution

The findings of the study contribute to the managerial cognition research and the analysis of cognitive structures at different levels of analysis by showing the relationship between the industry-level cognitive diversity and the decision-makers' demographic backgrounds. A key contribution of the study is to the managerial cognition research methodology, which is achieved by developing and operationalising the distance ratio measure for the analysis of cognitive maps to utilise more information available in the maps and align it with the decision-makers' characteristics. The study shows that the cognitive mapping methodology using distance ratio enables collecting managers' cognitive maps, aggregating them for further analysis at different levels of analysis and comparing their content and structure across the firms.

As for this thesis, the study focuses on the third sub-question concerning cognitive diversity at different levels of analysis and the relationship between demographics and cognitive diversity. The findings contribute to the managerial cognition literature, especially the analysis of cognitive structures at the individual, firm and industry levels by further developing the LSW formula 12 to include the area information of the maps in the formula. Furthermore, the findings contribute to the upper echelon research by linking the direct and indirect cognitive measures, namely cognitive diversity and managerial characteristics to explain organisational performance.

5.5 Publication V

Emergence and development of the cleantech industry: A cognitive construction approach

Objectives

The study focuses on the strategy frame research, especially the cognitive construction view of the industry which suggests that the collective changes in firms' beliefs in market boundaries drive the industry change. Drawing on this view, the study investigates the cleantech firms' beliefs of the future technology areas to identify development patterns in the collective strategy frames and propose an approach to capture the industry change. Thus, the overall objective of the study is to increase the understanding of the complicated dynamics of top managers' cognitive structures, strategy frames and industry development within the fast-developing industry.

Data collection

In this study, the firms' annual reports served as a mean to capture the attributes of top managers' beliefs, investigating the interplay between the strategy frames and the competitive environment (e.g. Barr et al., 1992; Nadkarni Narayanan, 2007b; Kaplan, 2008; Kiss & Barr, 2015). Annual reports are seen as a key tool for top managers to communicate with the firms' stakeholders although managers may have a limited practical role in preparing annual reports. However, top managers intensively contribute to the development of annual reports by incorporating their beliefs into them (Barr et al., 1992; Fiol, 1995). Prior research has shown that thematic information is manifested in annual reports with specific terms representing cognitive concepts, the frequency of which illustrates the importance and change in firms' attention to specific issues (Dutton & Duncan, 1987; Cho & Hambrick, 2006). They are assumed to represent proxies for top managers' priorities in a firm's strategies and perspectives (Kaplan, 2008). Thus, strategic statements in annual reports provide an aggregated firm-level measure for strategy frame (Schneider & Algemar, 1993).

Consequently, the data for the analysis were collected during 2018 from the annual reports of each firm over eight years from 2009–2016. The sample was drawn from a complete list of 144 firms in OMX Nasdaq Nordic Helsinki and Stockholm. The final sample of the firms covered 66 incumbent firms, including three non-traded firms that had a strong presence in the Finnish cleantech industry. The selected firms had their headquarters or a significant share of their operations in Finland, and the annual reports highlighted environmentally friendly technologies and services in their businesses. The final criterion for the selection required that the firms were traded in 2009–2016 stock exchange for covering the research period. In this study, the focus of the data is on the firms' mission and vision presented in the annual reports as reflections of the top managers' future beliefs embedded in the strategy frames. The mission and vision statements were extracted from the firms' annual reports into a single text file for content analysis.

Data analysis

The analysis of the data built on the advanced text analytics techniques and accordingly a software toolkit, which facilitated text extraction and coding of the textual content (Blitzer, 2007). MAXQDA software has been used for assistance in qualitative and mixed methods data and text analyses (Gibbs, 2013). The procedure for the retrieval and quantitative data analysis of the firms was presented in Section 3.4.

The contextual analysis of the annual reports was conducted using the terminology developed based on the related literature and the analysis of 20 annual reports, for example 'green energy, recycling society, life-cycle, online service, robotic, waste management, distributed energy systems, IoT, smart energy, resource efficiency, big data, IT, ICT'. Before creating the initial list for analysis, a workshop for two academic research projects funded by the Academy of Finland and Tekes, namely Digital Disruption of Industry and NeoCarbon, was organised in summer 2017 to develop alternative scenarios for the energy sector transformation. The 16 participants of the workshop were scientists and practitioners in the field of digital and energy technology business and research in Finland. The initial list of the terms was then divided into three wider categories of 'Renewable Energy, Sustainability, and Digitalization' to detect and illustrate the development patterns of the interrelating technology areas among the sample firms. Next, the lexical query was constructed using relevant keywords in each of the three concepts to detect the mentioned concepts within the annual reports. The relevant text segments based on the lexical query were then retrieved and stored under an automated coding system. Finally, the detected coded segments were subsequently utilised to specify the overlapping coded segments to indicate the year and the part of the mission and vision concepts that displayed the development patterns of the collective cognitive frame.

Findings

The findings of the study show that the incumbent firms' strategy frames hold the common assumption about the industry, displaying industry-level collective cognitive patterns concerning future technology development. The empirical findings display two developing phases in the industry-level collective strategy frame regarding the key technology areas embedded in digital solutions. Moreover, the findings demonstrate the differences between the firms' assumptions about future technology developments. These differences can be attributed to the firms' different social networks (i.e. industry sectors). Also, this study contributes to the managerial cognition research, demonstrating the appropriateness of mission and vision statements in the annual reports for eliciting firms' strategy frames and analysing the collective strategy frames.

Main contribution

The study contributes to the cognitive construction view of industry literature by examining the beliefs of the future in the mission and vision statements, representing the cognitive concepts embedded in the firms' strategy frames. The findings contribute to the analysis of the strategy frames, showing their development over time regarding the future developments of the key technology areas. The findings also contribute to research on the collective strategy frame of the industry by investigating the industry-level cognitive patterns among the cleantech firms. Besides, the study contributes to the industry transition research, especially the cleantech industry development by analysing the firms' beliefs of future developments in the annual reports.

As for this thesis, the study focuses on the fourth sub-question concerning the development of the industry-level collective strategy frame. The findings of the study advance our understanding of the firms' business environment as a socially constructed reality by identifying common cognitive patterns among the firms. In addition, the study contributes to the studies on the cognitive construction of industry by showing that the differences in the firms' strategy frames arise from the differences between the firms' assumptions about future developments based on their social networks (i.e. industry sectors).

5.6 Table of the summary of the publications

All five publications have a specific role in their contribution to this thesis. Table 2 shows the summary of each publication's objective, main findings, data, research question and contribution.

Table 2. A summary of the publications and their contributions of the thesis.

Sub-Question	Publication	Objectives	Primary Data	Main Findings	Main Contribution of the thesis
SQ1: How does the interaction between the firm's dominant logic and its strategic activities influence the firm's performance?	**Publication 1**: Managerial cognition and dominant logic in innovation management: Empirical study in media industry	To investigate the complicated relationship between dominant logic and innovation activities and its impact on business performance by operationalising the concept of dominant logic	103 responses from the editors-in-chief of the consumer magazines in Finland, Sweden and Russia, collected by a survey in 2012	Dominant logic influences firm performance in its interaction with innovation activities; dominant logic focusing on explorative activities drives long-term success and external collaboration whereas exploitative activities enhance short-term performance.	The study operationalises the concept of dominant logic to increase our understanding of the intertwined relationship between dominant logic, firms' activities and performance.

SQ2: How do the shared cognitive structures differ between the top and middle management within the firm?	**Publication 2**: Information processing approach in organisational cognitive structures: Relationship between top and middle managers' cognitions.	To analyse cognitive diversity differences between the top and middle managers and provide insights into the presence of dominant logic as a top management's shared cognitive structure	75 Cognitive maps of top and middle managers of an international transportation firm collected in 2015	The middle managers' shared cognitive structure is more focused compared to that of the top managers; middle managers' and top managers' cognitive maps display similar interpretative patterns, stressing economic issues over environmental and social issues.	The study provides an approach to analysing the cognitive structures at different organisational levels in quantitative bases with direct cognitive measures; the study demonstrates cognitive mapping with distance ratio as a method to collect and analyse cognitive information at different levels of analysis; the study operationalises the concept of dominant logic as a shared cognitive structure.
SQ3: What is the relationship between cognitive diversity and (a) organisational interpretation and (b) firms' outcomes?	**Publication 3:** Strategic interpretation on sustainability issues—eliciting cognitive maps of boards of directors	To examine cognitive diversity at different levels of analysis and its relationship with the centrality of the cognitive maps when the firms' key decision-makers make sense of sustainability management of the firm	43 cognitive maps and top managers' demographic characteristics from nine cleantech firms in 2014	Despite their business sectors, the firms emphasise economic issues over environmental and social issues in their perceptions; there exists a relationship between firm-level cognitive diversity and the centrality of the interpretation of the strategic	The study reveals the relationship between the firms' cognitive diversity and the industry-level interpretation of the strategic issues; the study advances the quantitative analysis of the cognitive structures by using the cognitive mapping method for collecting cognitive maps

				issues at the industry level.	and aggregating them into different levels for analysis with cognitive diversity and centrality measures.
	Publication 4: Cognitive diversity, managerial characteristics and performance differences across the cleantech firms	To advance research on cognitive structures at different organisational levels using the cognitive mapping method with distance ratio; to identify the linkage between cognitive diversity, demographic characteristics and firm outcomes	43 cognitive maps and top managers' demographic characteristics from nine cleantech firms in 2014	The decision-makers' board tenure, industry experience and age explain cognitive diversity in the aggregated maps; the study did not find any significant combined effect of the demographics on the decision-making groups and cognitive diversity, explaining the financial outcomes of the firms; the study shows variations in distance ratios when computed by LSW formula 12 and the developed LSW formula 12.	The study operationalises and develops LSW formula 12 to include the area information of the maps in the formula; the study contributes to the upper echelon research by linking the direct and indirect cognitive measures, namely cognitive diversity and managerial characteristics to explain organisational performance.

SQ4: How does the collective strategy frame develop over time among the incumbent firms?	**Publication 5**: Emergence and development of the cleantech industry: A cognitive construction approach	To investigate the development patterns of the collective strategy frame within the cleantech industry	Annual reports of 66 cleantech firms (2009–2016) collected in 2017	The findings show two developing phases for industry-level collective strategy frame regarding the key technology areas; the findings demonstrate the differences between the firms' assumptions about the future technology developments tracing them to the firms' social networks (i.e. industry sectors).	The study analyses the strategy frames, showing their development over time regarding the future development of the key technologies; the study contributes to the research of the cleantech industry development by analysing the development of the firms' future beliefs in the annual reports; the study increases our understanding of the firms' business environment as a socially constructed reality by investigating the collective cognitive patterns among the firms.

6 Conclusions

The main aim of this thesis was to provide new insights into the managerial cognition literature, especially the managerial cognitive structure research. The following research question was set to guide this thesis through the research process:

RQ: How do differences in strategy frames across the firms emerge within the industry?

The main RQ was divided into the four SQs as follows:

SQ1: How does the interaction between the firm's dominant logic and its strategic activities influence the firm's performance?
SQ2: How do the shared cognitive structures differ between the top and middle management within the firm?
SQ3: What is the relationship between cognitive diversity and (a) organisational interpretation and (b) firms' outcomes?
SQ4: How does the collective strategy frame develop over time among the incumbent firms?

The main research question summarises the answers to the sub-questions given in the findings of five separate publications presented in this thesis. The answers to the research questions allowed the findings to address the research gaps identified in the literature of managerial cognition; it also created an opportunity to advance the theory and develop the methodology of the field.

First, this thesis deepens our knowledge of managerial cognitive structures, especially strategy frame research, including the conceptual unity, assumptions and boundaries at the organisation and industry levels and updates; it also extends the concept of the shared managerial cognitive structure at organisation and industry levels. Second, the thesis advances the research methodology of managerial cognitive structures by developing the quantitative method for the analysis of cognitive maps. Finally, the thesis increases the understanding of the nature of the emerging cleantech industry as a social cognitive phenomenon of collective strategy frame. The implications for the theoretical and managerial contributions are elaborated in the following chapter.

6.1 Theoretical and methodological contributions

This thesis highlights and explains the complex dynamics of top managers' cognitive structures, strategy frame and industry-level collective strategy frame and their implications for firm outcomes (Porac & Thomas, 2002; Narayanan et al., 2011; Gavetti & Warglien, 2015; Cattani et al., 2017). Moreover, this thesis increases the conceptual unity in managerial cognitive structure research by operationalising the concept of dominant logic as an information filter and a shared cognitive structure (Bettis & Prahalad, 1996; von Krogh et al, 2000; Nadkarni & Narayanan, 2007a; Maijanen-Kyläheiko, 2014; Schraven et al., 2015). This study's significant contribution to the

literature relates to the research methodology. This study advances the managerial cognition research methodology using direct cognitive measures for elicitation and analysis of cognitive maps at different levels of analysis (Langfield-Smith & Wirth, 1992; Langan-Fox et al., 2000; Tyler & Gnyawali, 2009; Laukkanen & Wang, 2015; Schraven et al., 2015). Finally, this thesis provides insights into the emergence of cleantech industry as a collective social phenomenon (Davies, 2013; Georgeson et al., 2014; Planko et al., 2016) and brings forth the studies on industry and market boundaries (Nadkarni & Narayanan, 2007a; Hodgkinson, 2015; Cattani et al., 2017).

Theoretical contribution of this study relates to the strategic management literature by focusing on managerial cognition research, especially managerial cognitive structures, and applying two theoretical approaches, namely schema theory and the cognitive construction view of industry (Bettis & Prahalad, 1995; Erasmus et al., 2002; Nadkarni & Narayanan, 2007a, b; Tyler & Gnyawali, 2009; Narayanan et al., 2011; Gavetti & Warglien, 2015). Following Porac et al.'s (1989) seminal work on 'competitive groups as cognitive communities', a majority of the prior studies have embraced the socio-cognitive category structure of competitive groups in explaining industry boundaries and its relationship with firm outcomes (Kaplan, 2011). This thesis combines the two theoretical approaches and extends the research on managerial cognitive structures by focusing on collective aspects of cognitive structures and their consequences on firm outcomes. The key contribution, in particular, concerns the multilevel analysis of managerial cognitive structures, namely individual level (managers' cognitive structures), firm level (dominant logic and strategy frames) and industry level (collective strategy frame) with direct and indirect measures. In short, this study reveals new perspectives on the development of research on strategy frame and their presence at different organisational levels.

First, this thesis contributes to the operationalisation of the concept of dominant logic as an information filter (Bettis & Prahalad, 1996; von Krogh et al., 2000; Maijanen-Kyläheiko, 2014; Scharven et al., 2015) and a top management's shared cognitive structure representing the strategy frame of the firm (Lyles & Schwenk, 1992); Nadkarni & Narayanan, 2007a, b; Schraven et al., 2015). The prior literature on dominant logic has shown that dominant logic of the firm as an information filter manifests itself in management practices and processes that the firm pursues creating and implementing strategies; the literature also indicates that dominant logic directly impacts on firm performance (von Krogh et al., 2000; Kor & Mesko, 2013; Maijanen-Kyläheiko, 2014). This study sheds light on the interaction between the firms' strategic actions and dominant logic in relation to firm outcomes, demonstrating empirical measures for comparing the direct effect of dominant logic and its combined effect with innovation activities on firm outcomes. In this study, dominant logic was measured by how the firms conceptualise their external and internal environments. The innovation activities were measured by the type of innovation activities—exploitative or explorative—that the firms stress. In brief, this study shows that the interaction between dominant logic and the innovation activities and their effect on the firms' performance. From the strategy frame perspective, this thesis brings further the concept of dominant logic as a cognitive structure (Schraven et al., 2015) by measuring the differences between the top and middle managers' shared

cognitive structures within the firm. Prior studies show that top managers' assumptions embedded in dominant logic are assimilated into the cognitive structures of the lower-level managers (Schraven et al., 2015). This study shows that dominant logic as top managers' shared cognitive structure is broader in terms of area and distance ratio compared to that of middle managers. Besides, in this study, both management groups showed similar interpretative patterns in their cognitive structures over the strategic issues. In this regard, this thesis contributes to the research of the concept of the dominant logic and creates opportunities for its further development.

This thesis also contributes to the upper echelon literature (Hambrick & Mason, 1984; Cho & Hambrick, 2006; Narayanan et al., 2011). The majority of the studies in the field have used managerial characteristics as indirect cognitive measures to explain cognitive differences among firms' top managers and their relationships with firm performance (Narayanan et al., 2011; Bromiley & Rau, 2016). First, this thesis provides empirical evidence for the role of top managers' perception, organisational strategic choices and firm performance. The study shows the impact of the firm's dominant logic as an interpretative filter alongside the innovation activities on firm performance by analysing the interpretations of top managers (i.e. editors-in-chief in *Publication 1*) of their environment as direct measures. Second, by using cognitive maps as direct cognitive measures to analyse differences in cognitive diversity between the top and middle managers within the organisation, this thesis illuminates the transfer of top managers' interpretation of a particular strategic domain to the lower levels of the organisation. Third, the thesis sheds light on the relationship between actual cognitive diversity and top managers' characteristics by analysing it across the firms within the industry. To sum up, this study shows a relationship between the top managers' demographic backgrounds and the industry-level cognitive structures. Through this knowledge, this thesis provides a fine-grained understanding of the organisation as a reflection of its top managers and creates opportunities to develop the upper echelon approach.

Second, a key contribution of this thesis concerns the managerial cognition research methodology, especially cognitive mapping with direct cognitive measures (Markoczy, 2001; Tyler & Gnyawali, 2009; Ackermann et al., 2014; Laukkanen & Wang, 2015). The recent managerial cognition literature has identified a paucity in development of methods providing direct access to human actors' cognitive structures (Gnyawali & Tyler, 2005; Tarakci et al., 2014; Hodgkinson, 2015; Hodgkinson et al., 2015; Schraven et al., 2015). The prior studies on schema and the cognitive construction theory fields have investigated cognitive categorisations, explaining industry-level cognitive frames and their consequences for firm outcomes (Porac & Thomas, 2002; Kaplan, 2011; Cattani et al., 2017), and cognitive maps, explaining cognitive differences between the cognitive frames of individuals, firms and industries and their implications for organisational outcomes (Langan-Fox et al., 2001; Hodgkinson et al., 2004; Narayanan et al., 2011; Ackermann et al., 2014). The studies analysing managers' cognitions at different organisational levels have been aggregating cognitive concepts derived typically from the archival data and quantitative survey data, for example developed cognitive maps based on the annual reports to analyse performance differences across the firms (Nadkarni & Barr, 2008;

Kaplan, 2011; Kiss & Barr, 2015; Cattani et al., 2017). This thesis approaches the managerial cognitive structures based on direct cognitive measures and their implications for organisational outcomes by analysing the cognitive maps at different analysis levels within and across the organisations. For this purpose, the direct measures, cognitive diversity and degree of centrality of cognitive concepts are combined and linked to the indirect measures of managerial cognition (e.g. managerial background information).

Doing so, this thesis also advances *quantitative analysis of managerial cognitive maps*. *First*, the methodology is advanced by operationalising the original Langfield-Smith and Wirth's (1992) LSW formula 12 and developing it further to take into account more information available in the cognitive maps. This is made possible by including the area information of the cognitive maps in the LSW formula 12 and comparing it with the original LSW formula 12. S*econd*, the methodology is advanced by providing a comprehensive approach to collecting, analysing and aggregating managerial cognitive structures at different levels of analysis at individual, group, firm and industry levels using quantitative analysis methods for cognitive maps (Eden et al., 1992; Markoczy & Goldberg, 1995; Langan-Fox et al., 2001; Tyler & Gnyawali, 2009; Laukkanen & Wang, 2015). The approach used in this thesis advances the methodology by combining the distance ratio showing cognitive diversity with the degree of centrality of the cognitive concepts, illustrating the relevance of the concepts in the cognitive maps. Thus, the study deepens our knowledge not only of the cause-effect relationships but also the relationship between the cognitive constructs embedded in the shared cognitive structures and cognitive diversity across the firms (Tegarden et al., 2009; Tyler & Gnyawali, 2009; Schraven et al., 2015). *Third*, the empirical test of the further developed LSW formula 12 in the analysis of the top managers' demographic backgrounds and cognitive diversity across the firms shows that the approach is appropriate for comparing cognitive structures within and across different levels of analysis. Further, this study compares distance ratios computed by the original LSW formula 12 and the developed formula that includes the area information of cognitive maps in the LSW formula 12, causing differences in the Spearman's correlation rankings. Therefore, the LSW formula 12 with the area information can take into account more information about the content and structure of a cognitive map and hence serve as a stronger indicator of the diversity of shared cognitive structures than the original LSW formula 12. These developments create opportunities for the comprehensive analysis of managerial cognitive structures at different levels of analysis and shows the future potentiality of mathematical tools in managerial cognition research.

Thus, this study addresses the persisting methodological problem of aggregation of managerial cognition discussed in the prior studies (Porac & Thomas, 2002; Nadkarni et al., 2011; Powell, 2011; Hodgkinson, 2015, Laukkanen, 2018) by providing an approach to investigating managers' cognitive structures at different levels of analysis and bringing the strategy frame research closer to the empirical facts and integrating it with strategy practice. Thus, this study continues the development work of managerial cognition research methodology and addresses the identified gaps in recent managerial cognition literature.

Third, from the conceptual development perspective, the prior literature on managerial cognition, especially shared managerial cognitive structures research including studies on cognitive construction view and research on behavioural strategy of firms, have shown the diversity in conceptual unity in the field (Hodgkinson & Healey, 2008; Powell et al, 2011; Narayanan et al., 2011; Cattani et al., 2017). The studies have noticed the change from decisions to complex judgments, from individual-level biases to broader choice architectures and from introspection to complex social systems (Powell et al., 2011; Csaszar & Levinthal, 2016). As this thesis adopts two theoretical views, it contributes to the development of two intertwined theoretical concepts, namely strategy frame and dominant logic, by supporting methodological pluralism with multiple data sets in the research of shared cognitive structures at different levels of analysis. This opens up new lines of the initial development of theoretical reasoning with the potential for a comprehensive understanding of the social cognitive dynamics of the organisation and industry leadership and further advances in conceptual integration in the field.

Fourth, this thesis contributes to research on the development of the cleantech industry (Davies, 2013; Georgeson et al., 2014; Planco, 2015; Hahn et al., 2015; Mäkitie et al., 2018) and broader research field of industry conditions (Eisenhardt, 1989b; Tsoukas, 1996; Nadkarni & Narayanan, 2007a; Benner & Tripsas, 2012; Hodgkinson, 2015). Despite intensive research in the field, very few studies have approached the cleantech industry development from the managerial cognition perspective (Planco et al., 2015; Hahn et al., 2015). By implementing the schema theory and the cognitive construction view of the industry to analyse top managers' cognitive structures, this thesis sheds light on the development patterns of the cleantech industry as a result of changes in collective strategy frames. Consequently, this thesis continues this relatively new line of research and increases the understanding of the role of firms' different social networks in interpreting the changing business environment, creating collective cognitive structures and highlighting their implications for organisational outcomes in the context of the cleantech industry.

The validity of the contributions was assessed during the review processes of the publications included in the thesis. Further, as in mixed methods research, the findings of the study were approached from different theoretical perspectives; different research methods and sources were used for data collection and analysis. Consequently, the validity of the contributions lies in their possibility of triangulation.

6.2 Managerial implications

A key challenge facing firms is developing a comprehensive understanding of the competitive environment and interpreting the influence of competition on industry and business. This thesis attempted to increase managers' awareness of the environmental changes and their understanding of the meaning of top managers' shared cognitive structures for firm outcomes and strategic actions.

At the firm level, the findings highlight the role of top managers interpreting the environmental cues and translating them into successful strategic actions. Upper echelon studies have shown that top managers select, collate and interpret information for the firm as a whole. Consequently, dominant logic and strategy frame refer to the cognitive structures that top managers use in making strategic decisions and allocating firms' scarce resources. Cognitive diversity in these frames may cause inertia within the organisation and a decision-making group to achieve the final agreement for action and diminish organisational responsiveness to environmental changes. On the other hand, cognitive similarity may cause emergent opportunities and threats in the business environment to be overlooked. Thus, it is important for firms to recognise such cognitive differences that shape their interpretation by enhancing and limiting their members' abilities to identify changes in their environment and, in turn, firms' abilities to adapt to those changes.

Furthermore, the thesis provides important insights into the relationship between top managers' demographic backgrounds and cognitive diversity within the decision-making groups. The findings suggest that the level of cognitive diversity indicate decision-making groups' potential for analysing the business environment and making decisions. For example, cognitively homogenous groups may overlook or misinterpret changes in their business environments, exposing them to short lead-times and biases in decision-making. Heterogeneous groups, however, may cause lengthy negotiations, leading them to make compromises and make inefficient decisions. Thus, understanding cognitive diversity within a group, the roles and tasks of individual members can be evaluated in that particular group, and their expertise can be utilised most purposefully in line with the firms' goals.

This thesis also stresses the importance of considering firms' environment created by themselves rather than predetermined externally as 'a given'. The findings suggest that firms actively attempt to modify their environments by developing common assumptions, business networks and feedback mechanisms that drive their strategies and collective actions. This indicates that firms should pay attention to their assumptions about the development of the business environment and assess their appropriateness *vis-à-vis* collective assumptions. For example in the cleantech industry, firms' collective assumptions about the future reflect similarities in the development patterns of particular technologies, which may increase competition among the firms.

From the methodological point of view, the thesis provides a systematic approach to analysing how the industry drivers are perceived across the firms and how these interpretations help predict firms' future performance. The approach demonstrates the applicability of the hybrid cognitive mapping technique to the quantitative measure to capture managerial cognitions within an organisation, providing new knowledge on shared cognitive structures in different organisational levels (i.e. top and middle management levels). It also suggests the usage of multiple data sources and methods, bringing strategic management theories closer to the empirical evidence and integrating strategy research with strategy practice.

The findings of this thesis should also inspire policymakers to identify the mechanisms that drive the cleantech industry development. The findings revealed that the cleantech industry is emerging and encompasses different industry sectors and firms with varying priorities in their strategies concerning key technology areas. For example, the firms still lack a stable, shared understanding of the competitive boundaries of the cleantech industry, and thus, policymakers could review the current policies or formulate new ones to drive the firms' and other organisations' activities towards the desired, sustainable future.

6.3 Limitations and future research avenues

There are some inherent limitations in this study that need to be mentioned. The generalisation of the results is an important issue mainly because of the methodological choices of the study. Also, the data collection has some limitations despite the use of different methods and data sources.

First, the mixed methods research design with qualitative research approach as a main method typically focuses on a limited number of informants, i.e. representatives of the companies and organizations as in this study. Another aspect is that the study is conducted in real-life organisations, and it is often difficult to replicate the case. Therefore, this may raise concerns about the generalisability of the results of this study. As a result, the study may have specific limitations; however, this is not a sufficient reason to ignore its contributions. The limitations of this study are common to qualitative case studies in the field of business and management research.

Second, as this study focuses on understanding the social phenomenon of human cognition within and across the organisations, a question may be raised about the transferability of the results, although the data were collected from various firms and different industry sectors and countries. The data used in this study refer to the social studies and constructionism, assuming that social actors construct reality and, therefore, influence the kind of knowledge that can be obtained as well as how an observer (e.g. a manager) can distil the 'truth' and 'false' from the flow of knowledge. As this thesis is positioned in a middle ground between naïve realism and naïve relativism aligned with critical realism, it assumes that there exists an observable reality independent of our knowledge, although only imperfectly and probabilistically apprehensible in terms of epistemology. This has important implications for conducting studies on social systems (e.g. business organisations studied herein). In such contexts, the conditions are rarely equally controllable and accurately measurable, and therefore validity, reliability and generalisability are important issues to be considered when assessing the results of this study. However, recent studies in the field of management and business have introduced critical realism as a powerful tool in understanding the interplay between structure and agency in unobservable generative mechanisms (Järvensivu & Törnroos, 2010; Zachariadis et al., 2013; Hodgkinson, 2015; Lee et al., 2015). Regarding the managerial cognition research, in the present era when many fundamental truths are reconsidered, 'critical realism offers […] an attempt to achieve a more integrated and complete analysis

of the interplay between cognition, action, and outcomes in industries and business markets and beyond' (Hodgkinson, 2015: 22). Thus, comparing different philosophical assumptions for analysing the relationship between the managerial cognitive structures and the organisational outcomes opens up an interesting research area.

Third, the cognitive mapping method used for data collection has some limitations. In the studies presented in this thesis, the method is applied to describe, simulate or anticipate 'human thinking'. This is a problematic issue and, therefore, capturing managers' cognitive structures only provides representations of representations. The method should be considered an instrument for displaying cognitive structures, aiding the analysis of situations and events concerning strategic decision-making. Because of the problem of capturing and representing cognitive structures, which are invariably unique and temporary constructs, the validity of the method should be factored in when assessing the results. Thus, some scholars have argued that the relationship between the 'true' and revealed cognitive structure is never ideal and is influenced by the social context and the moment in which it occurs (Niccolini, 1999; Hodgkinson, 2015). Despite the ontological and epistemic cautions about data being the representation of organisational cognitive structures, they can provide insights into what managers actually believe and perceive.

One particular limitation concerns the contextual issues that should be considered with regard to the generalisation of the results. Both cleantech and media industries, as research contexts, are continuously changing due to fast technological developments, and therefore research settings are difficult to control and replicate. Nonetheless, the limitations discussed above also offer promising avenues for future research.

An existing research avenue is to combine wider qualitative and quantitative data sets with direct and indirect cognitive measures to deepen the understanding of social cognitive dynamics across organisations and enhance the triangulation of results. Another direction for further research is to extrapolate the results to a wider population of cleantech and media industry organisations, which could create new opportunities to compare the role of different industries. Another interesting field of research is to develop the cognitive mapping methodology to examine the collective change of cognitive structures in real time to tackle the temporary nature of cognitive maps.

This thesis also opens up the research avenue for the continuation of the conceptual development of strategy frame as a measure for the social phenomenon of industry change, applying cognitive mapping methods to direct cognitive measures to identify the actual change in collective cognitive frames. This provides an opportunity to increase the consistency in the theoretical assumptions about the cognitive construction view of the industry and the conceptual unity in the field of strategy frame research.

Finally, from the policy perspective, an interesting research avenue is to observe the effect of government funding in science and technology programmes on the development of industry-level cognition and their consequences to R&D and innovation intensity among

the firms. These research avenues are particularly useful to comprehend better the dynamics and forces involved in the formation of emerging industries such as cleantech.

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Appendix 1. Collecting the cognitive maps

Summary of the study

The purpose of this study is through elicitation of shared mental maps to investigate interpretative diversity within top management and find out its effects on strategic orientation and performance of the firms. *Shared mental maps of executives store* the Dominant Logic of the firm that channels attention to organizational activities and shape the strategy of the firm. *Dominant Logic* gives the frames for the organizational operations and determines firm's identity within the industry. Dominant logic expresses the *strategic and performance orientation* of the firm.

The study aims by means of causal mapping technique to open up the dynamics that drive corporate sustainability in the context of cleantech industry, and further to find out how some firms are able to *break the dominant logic of the industry* to be more innovative than other firms.

Sustainability management

The aim of sustainability management is to support firms' long-term value creation and improve its performance. During the past decade, sustainability has been demonstrating increasing importance in firms' performance and strategies. Today, sustainability has gained a central role in development of competitive advantage of the firms.

The World Commission on Environment and Development has determined "sustainability" as 'economic development that meets the needs of present generation without compromising the ability of future generations to meet their own needs'. From this point of view, in firm level, sustainability management involves three key aspects, namely Economic benefits, Environmental benefits, and Social benefits.

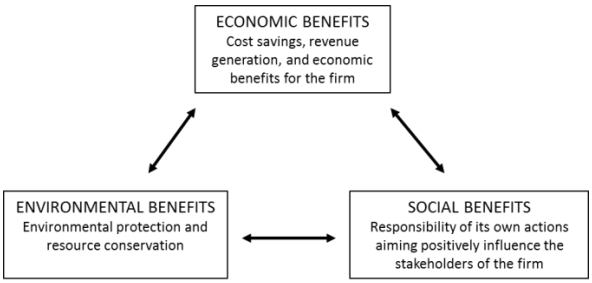


Figure 1. Sustainability management and key cornerstones.

As a whole, sustainability promotes entire business sectors generating continuously increasing market demand for them, e.g. renewable energy, investment banking and fund rising, machinery, food industries. At the same time, it may restrict business development in some industries forcing them to renew themselves, e.g. paper, energy, and logistic industries. Sustainability can be seen as a core theme in firms' strategies developing existing and new business.

INSTRUCTION FOR THE FIRST ROUND:

1. Read the introduction (above).
2. Read through the list of the strategically relevant topics on sustainability management. (Table below)
3. Select twelve (12) most relevant topics (in the table) **for the Firm** from your personal point of view
4. Fill your background information into the table below
5. Next, the second round of exercise.

Please, fill your background information into the table below:

Background Information		[X]
1. Your Education	MSc (tech)	
	MSc (econ)	
	MA	
	MBA / eMBA	
	Dr	
	BSc (tech)	
	BSc (econ)	
Other:		
2. Your age	< 30 years	
	30-45 years	
	> 45 years	
3. Industry experience	< 5 years	
	> 5 years	
4. Industrial Background	Energy	
	Forest	
	Machinery	
	Chemical	
	Banking	
other:		
5. Working in board/TMT	< 5 years	
	> 5 years	
6. You work as / in	Top Management	
	Middle management	
	Expert	

Please, evaluate the Table and make your selections by checking 'X' (See below):

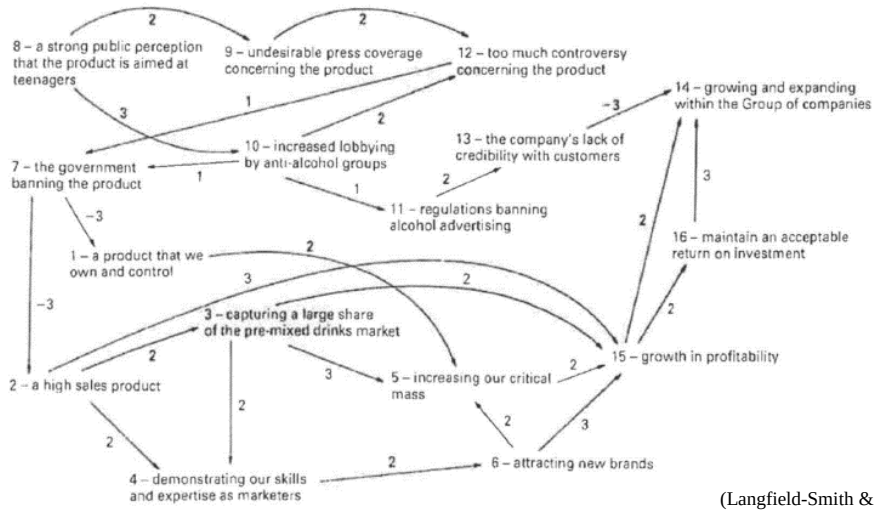
Table: Pool of strategic topics on sustainability. Select 12 most relevant topics.

No.	**Firm's strategic sustainability issues:**	**Selection [X]**
1	Employment contribution in the region	
2	Use and development of environmentally friendly technologies in products	
3	Freedom of association (labour unions etc.)	
4	Corruption	
5	Sales	
6	Shareholder value	
7	Turnover	
8	Product/service safety	
9	Public funded projects (EU and National)	
10	Biodiversity in all activities of the firm	
11	Energy use of products/services	
12	Resource overuse (logistics, services, products)	
13	Transport/logistic of products/services	
14	Water use and emissions of products/services	
15	Customer satisfaction	
16	Child labour	
17	Employee training and education	
18	Equal opportunities and non-discrimination of employees	
19	Health and safety (employees and citizens)	
20	Management quality (labour turnover, work satisfaction)	
21	Stakeholder involvement and liaison with NGOs, universities,	
22	Social partnership and sponsorship	
23	Wages and benefits of employees	
24	Stakeholder involvement and liaison with business partners	
25	Purchasing operations	
26	Sustainability reporting	
27	Mission and vision	
28	Brand, company image	
29	R&D investments	
30	Corporate governance (e.g. transparency, following rules/regulation)	
31	Ethical behaviour and human rights	
32	Corporate citizenship and charity work	
33	Lobbying (direct and indirect)	
34	Long term profitability	
35	Short term profitability	
36	Employees attitude	
37	Growth of the firm	
38	Competition in the market	
39	Prices applied by the Firm	
40	Customer relations	
41	Legal/regulative expertise in sustainability	
42	Technological expertise in renewables	
43	Leadership within the organization	
44	Investments in marketing	
45	International business growth	
46	Bank connections	
47	Relations with suppliers	
48	Knowledge of needs of market (domestic)	
49	Knowledge of needs of market (international)	
50	Sustainability strategy	

INSTRUCTIONS FOR THE SECOND ROUND:

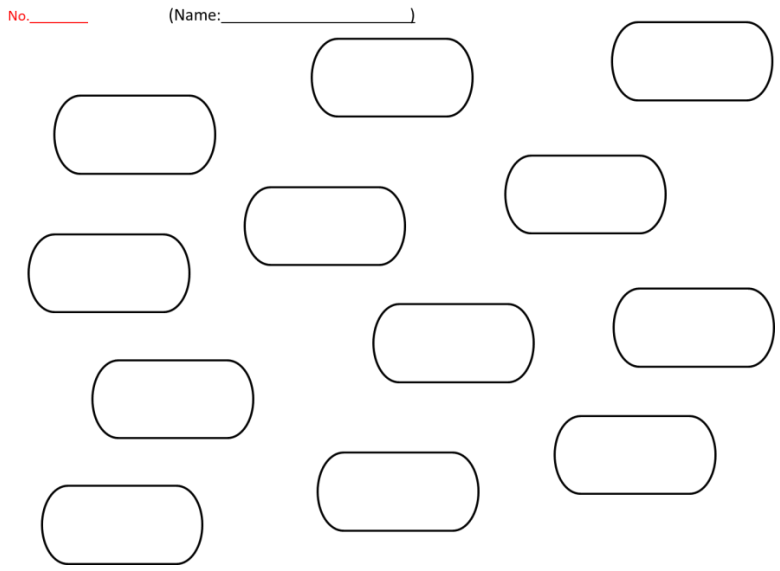
1. Write your name or ID number in the top of the map
2. Your task is to find out the causalities between all constructs/nodes you selected in the list of strategic issues
   - There can be nodes that effect only on one other node
   - There can be nodes that effect on many other nodes
   - See the example of a map included in the instructions
3. After notified the causality between the nodes
   - Draw (by hand) the lines between them (e.g. 7-11)
   - Select the direction of the causality by using arrow (e.g. 7 → 11)
4. After notification of the causality, determine strength of impact and positivity / negativity of it on the following scale
   - Strong (3), Moderate (2), Light (1) and positive/negative impact
   - Scale: -3 -2 -1 -- 1 2 3

An example map



(Langfield-Smith & Wirth, 1992)

The map to fill



Appendix 2. Descriptions of the case Firms

The Firm	Description
Case firm 1 [A in publications]	a regional energy generation and distribution company. The firm is owned by the municipality. The main businesses are district heating and cool, electricity generation and distribution, energy efficiency services. It has 200 000 customers, net sales was ca. 150 Million €, employees over 90, and it operates in national level, however, the main business area is in Eastern Finland. During the resent years, the firm has been focusing its businesses towards sustainable business utilizing increasingly renewable energy sources for energy production, e.g. heating and cooling energy and electricity.
Case firm 2 [B in publications]	an international equipment manufacturer. Founded in 1961, a Finnish family-owned energy and environmental technology company. The headquarters is in Lahti, Finland. The key products are used, for example, in power plants, waste incineration, marine boilers, district heating plants, for heating or cooling large buildings and facilities, and for heating private houses. We have production facilities in Finland, USA, Russia and China. In addition, we have sales offices in Russia, Brazil, and United States as well as resellers in more than 30 countries. Net sales of the firm was 45 Million € in 2018, employees 350 globally.
Case firm 3 [C in Publications]	an international equipment manufacturer having production units in several cities in South Finland. The headquarters is in Eastern Finland. The firm is an industrial solutions provider for demanding process conditions. The firm was founded 40 years ago as a flow control and elastomer technology firm, which is still owned by the same family. Today, it is one of the leading producer of heavy duty valves, pumps and systems in Europe. The net sales of the firm was over 40 Million €, employees globally 140 in 2018. The key customer segments are Mining, Minerals & Metallurgy and Energy & Environment industries.
Case firm 4 [D in Publications]	an equipment manufacturer locating in Eastern Finland. Firm's operational fields include energy, pulp and paper, mining, chemical, and environmental technology sectors focusing on solutions and equipment, which are ecologically friendly. The key products are conveyers, elevators, and related products. The net sales of the firm was 12 Million €, and employees 50 in 2018. The firm is over 30 years old family owned company having the main office in Eastern Finland.
Case firm 5 [E in Publications]	an international energy generation firm operating in Nordic and Baltic countries. Firm's operational fields include operation and construction of middle range energy generation units and distribution networks for district heating and cooling for as well as large scale-building complexities. The focus is in renewable energy. The net sales of the firm was over 200 Million € with over 370 employees in 2018. The firm is owned by the management and an investment company having the main office in South Finland.
Case firm 6 [F in Publications]	a small renewable energy generation firm operating in Finland. Firm's operational fields include operation and construction of middle range energy generation units and distribution networks for district heating and cooling for as well as large scale-building complexities. In addition, the firm provides consulting services in energy efficiency and modernization of the existing fossil based systems to renewable systems. The net sales of the firm was over 3 Million € with over 7

	employees in 2018. The firm is owned by the management and the municipal energy companies having the main office in South Finland.
Case firm [G in Publications]	a medium size equipment manufacturing firm operating globally in the field of in indoor air energy efficient solutions for demanding spaces throughout the product life cycle. The net sales of the firm was 205 Million € with over 1500 employees in 30 countries in 2018. The firm is over 50 years old family owned firm having the main office in South Finland.
Case firm 8 [H in Publications]	a medium size firm operating in Nordic countries in the field of metal structures consisting of engineering design, laser cutting, bending, welding, wet and powder coating, and assembling stages. The net sales of the firm was 15 Million € with over 100 employees in 2018. The firm is 20 years old firm owned by the management and an investment company having the main office in Eastern Finland
Case firm 9 [I in Publications]	a small financial company operating in Nordic countries focusing on financial services in different industry sectors with sustainable goals. The net sales of the firm was 8 Million € with nine employees in 2018. The firm is over ten years old family owned company in South Finland.
Case firm 10	an international transportation firm having 52 sub-units operating globally in the field of cargo and passenger transportation. The revenues of the firm was 38 Billion € with 830 000 employees in 2017. The firm is over 100 years old state owned multinational company.

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