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Corporate Foresight: A Bibliometric Analysis on Research Trends

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Master's in Management of Services and Technology

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BUSINESS
SCHOOL

Department of Marketing, Strategy and Operations

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This dissertation is dedicated to my family and my friends, who always supported me during my academic journey and helped in my exciting endeavors!

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Resumo

A pressão influenciada pela célere disseminação das inovações tecnológicas aumentou a imprevisibilidade dos ambientes de negócio dificultando as capacidades de decisão e de atuação das empresas, quando confrontadas com incertezas de mercado.

Corporate foresight (CF) é um instrumento de gestão fundamental, que tem sido objeto de estudo nas últimas décadas. O CF capacita as empresas com melhores posições de mercado e lucros sustentáveis lidando também com a incerteza o que e proporciona vantagens competitivas a médio-longo prazo. Este estudo tem como objetivo identificar tendências de investigação sobre CF tendo como base estudos anteriores. A partir de uma *query* criada no *Web of Science (WoS)* obtivemos a nossa amostra inicial de dados, compreendida entre o período de 2001 a 2021. Assim foi-nos permitido estudar a frequência de publicações e citações totais bem como, analisar descritivamente jornais, autores, palavras-chaves e referências. Posteriormente realizámos uma análise bibliométrica utilizando o *software CiteSpace* para examinar padrões e tendências de investigação. Os resultados da análise bibliométrica sugerem um progressivo interesse em *open foresight* e a oportunidade de novas investigações explanatórias como instrumento de compreensão e validação do *corporate foresight*.

Palavras chave: *Corporate Foresight*; *Strategic Foresight*; *Open Foresight*; Análise Bibliométrica

Códigos de Classificação JEL: M15; O32

Abstract

The pressure on companies, influenced by the rapid dissemination of technological innovations increased the volatility of business environments making difficult for companies to decide and act when faced with market uncertainties.

Corporate foresight (CF) is a fundamental management tool, which has been object of study in recent decades. CF enables companies to achieve better market position, sustainable profits and ultimately provides competitive advantages in the medium/long term, while also dealing positively with uncertainty. This research aims to identify investigate trends in CF based on previous studies. From a query created in Web of Science (WoS), we obtained our initial data sample, comprised between the period 2001 to 2021. Thus, allowing us to study the frequency of publications and total citations, as well as descriptively study journals, authors, keywords, and references. We then carried out a bibliometric analysis using CiteSpace software to study research patterns and trends. The results of the bibliometric analysis suggest a progressive interest in open foresight and the opportunity for new explanatory research as a method for understanding and validating corporate foresight.

Keywords: Corporate Foresight, Strategic Foresight, Open Foresight, Bibliometric Analysis

JEL Classification Codes: M15, O32

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List of Abbreviations

CF – Corporate Foresight

ICT – Information and Communications Technology

LLR – Log-Likelihood Ratio

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LSI – Latent Semantic Indexing

MI – Mutual Information

MNCs – Multinational Corporations

NF – Networked Foresight

OF – Open Foresight

R&D – Research and Development

RBV – Resource-Based View

SMEs – Small and Medium Enterprises

WoS – Web of Science

.txt – Text file

1. Introduction

Nowadays, with the increased power of ICT (Information and Communications Technology) on social and economic development, due to the rapid technological changes and the fast-moving diffusion of innovation, the business environment has become highly uncertain (Latzer, 2009).

According to Vecchiato and Roveda (2010), uncertainty is the managers' incapacity to assign correct probabilities to the chance that specific events and drivers of change will occur. Uncertainty becomes even vaster in accelerated and dynamic environments and if not managed properly chaos can overcome companies (Battistella & De Toni, 2011). Rising levels of uncertainty increase the need to comprehend the dynamics of the business environments (Rohrbeck et al., 2015). In line, Vecchiato (2015), mentioned that companies are strained to make decisions under "*bounded rationality*" circumstances. Companies and their managers are not capable to gather, process, and understand information about changes and new events that occur externally to their environments (Vecchiato, 2015), and eventually, it leads to diminishing predictability of upcoming changes (Muhlroth & Grottke, 2020).

Vecchiato and Roveda (2010), described the three types of uncertainty: "State" uncertainty, the incapability to comprehend the factors that lead to environmental change; "Effect" uncertainty, the difficulty to predict the impacts of that environmental change in the company; And, "Response" uncertainty, the ineptitude to realize the best responses and the consequences of those choices. The authors also introduced two general features that contribute to uncertainty: "*complexity*" - the higher the diversity of events in the business environment, the higher the complexity - and "*rate of change*" - the higher the rate of change the more and faster events occur in the external business environment, increasing the difficulty to make strategic decisions. Companies must seek the drivers of change and they must be relevant and disruptive to gain sustainable competitive advantages, especially for market leaders battling with new incumbents, usually disruptive. Market leaders must take a chance on the discontinuous drivers of change to maintain their long-term market position and profitability (Vecchiato & Roveda, 2010). In line, Bennett and Lemoine (2014), mention that when leaders stop innovating, their organizational performance plummets.

According to Bennett and Lemoine (2014), leaders must reorientate their "strategy to a less elitist and more mundane activity, from analysis to interaction", increasing the intrinsic value of their strategy by dealing with external events that are easily understood. Therefore, it is necessary to build pre-alarm systems to manage the environment turbulence (Battistella & De

Toni, 2011), by creating a future-focused strategy, especially for market leaders that can be pressured by incumbents, by anticipating threats, such as technologies, customer needs, and regulation, analyzing trends and creating opportunities (Vecchiato, 2015).

Many authors considered that environmental uncertainty is linked with the increased volatility of the business environment that, in turn, is related to the fast pace of globalization, the meddling of geopolitics in global economic activities (regulations), rapid changes of competition, dispersion of organizational sources of innovation and manufacturing, accelerating rates of knowledge production and distribution, the widespread of revolutionary technologies and shorter technological life cycles (Bereznoy, 2017; Scheiner et al., 2015; Amati et al., 2020; Rotjanakorn et al., 2020; Teece, 2007; Latzer, 2009). All these issues contributed to increasing difficulties in technology planning and innovation management, and eventually, it induces companies to pursue novel innovation management mechanisms (Milshina & Visghnevskiy, 2018), as well as a reassessment of the nature and processes of strategic decision making (Schweitzer et al., 2019). Scheiner et al. (2015), stated that the "high technological level of product in combination with the acceleration in the development of new technologies has created a ´*technology fog*´". This results in a decrease in technology visibility and identification, an increase of information overload, and eventually complexity (Scheiner et al., 2015).

Since technological innovation is a key driver of economic growth and human progress (Broughel & Thierer, 2019) and, as already mentioned, one of the factors environmental uncertainties, (Calof et al., 2018) affirmed that "firms need to develop the ability to anticipate changes and determine consequences of alternative responses to those changes". Additionally, Scheiner et al. (2015) suggested that it is a must for companies to identify the potential of new technologies promptly, under volatile conditions and deficient knowledge. However, the author, Scheiner et al. (2015) also specified that timing is a new challenge since newer technologies are up-and-coming and a late assessment of those technologies, increases the pressure to make strategic decisions, and eventually, it can lead to a loss of competitive advantages. More now than ever there is a need to emphasize experience and intuition in decision making (Scheiner et al., 2015). Therefore, von der Gracht et al. (2010) said that the shift from a traditional industry-driven economy to a knowledge-based economy requires new approaches to gain competitive advantages. Inline Rotjanakorn et al. (2020) mentioned that, nowadays, achieving sustainable competitive advantages goes beyond the resource-based view (RBV) and capability theories. These theories only work in normal operating conditions and are not appropriate to a complex, fast-moving, and volatile business environment (Bereznoy, 2017; Rotjanakorn et al., 2020).

According to Battistella and De Toni (2011) organizations are "complex adaptive systems", dependent on their expectations and, must be capable of modifying their behavior by learning faster about competitors and industry, devising strategies, analyzing trends and future opportunities. Therefore, Battistella and De Toni (2011) noticed that there is a need for strategic fit - companies need processes to keep track of the consistency and positioning of their strategy (the internal perspective) as regards to weak signals and trends (the external perspective). For Battistella & De Toni (2011) the strategic fit is a crucial managerial goal associated with the companies' capability to adjust to the business environment context.

Many scholars such as Bereznoy (2017), Battistella and De Toni (2011), Vecchiato (2015) and Rotjanakorn et al. (2020), talked about the approaches to battle environmental uncertainty and agreed that the most commonly used approaches or the conventional approaches ("*the planning school*" – Michael Porter, Harri Igor Ansoff), in strategic management, are becoming highly ineffective in a wide set of industries and this is stimulating a reassessment of the strategic processes and decisions. Dadkhah et al. (2018) goes further and specified that there is a shortage of frameworks that focus on future managerial economics and at the same time tackle the external changes by developing meaningful solutions.

Bereznoy (2017) mentioned that a new approach has begun to take shape. An approach that, according to Rohrbeck and Gemünden (2009) is based on the development of ambidextrous capabilities to ensure long-term survival and competitiveness; An approach, as reported by Ratcliffe (2006) is based on a mindset that "embraces individualism, collaboration and innovation (…) addresses social, environmental and economic imperatives (…) and above all a mindset that can tackle complexity, uncertainty, and change (…); a mindset that is oriented to process rather than a structure; that is ecologically driven rather than hierarchically driven; that is value-added rather than competitive; that is holistic rather than functional; and, that is collaborative and innovative rather than adversarial and derivative" (Ratcliffe, 2006); An approach that, according to Milshina and Visghnevskiy (2018) should increase the dynamic capability of a company to process information and to develop new and optimize technological strategies and eventually reduce risk; An approach that, following Wiener and Boer (2019) does not rely exclusively on internal capabilities but rather focuses on strategic alliances.

This approach is called Corporate Foresight (CF) and it is a key instrument to battle uncertainty (Bereznoy, 2017). Kononiuk & Sacio-Szymańska (2015) mentioned that CF research has become a relevant contributor in the accelerating change, the high business environment uncertainty, and the outrageous amount of information. Darkow (2015) and Battistella & De Toni (2011) mentioned that CF is a long-term focused instrument that helps to

formulate possible future scenarios and the variety of foresight tools support the decision-making process. Additionally, Ratcliffe (2006) affirmed that a future-oriented approach, with robust foresight capabilities and capacity, supported by adaptable systems, is a critical success factor. Corporate Foresight is identifying, observing, and interpreting factors that induce change, determining possible organization-specific implications, and triggering appropriate organizational responses. It involves multiple stakeholders and creates value through providing access to critical resources ahead of the competition, preparing the organization for change, and permitting the organization to steer proactively towards a desired future (Rohrbeck et al., 2015).

The purpose of the paper is to understand current trends in CF research by quantitatively, computationally, and systematically reviewing the literature corpus. Previous efforts to review this study field have been qualitative, such as Daheim and Uerz (2006), Rohrbeck et al. (2015), Adegbile et al. (2017), Iden et al. (2017), and Gordon et al. (2020). Thus, there is a gap to be fulfilled where quantitative and computational analyses are used to identify future research patterns. This study aims to provide the first bibliometric analysis exploring corporate foresight literature. However, it must be noticed that, to our knowledge, there are already two publications that performed bibliometric analysis: Gibson et al. (2018) on technology foresight and Amini et al. (2021) that studies regional foresight. Though, our research will have a broader perspective. To proceed with this analysis CiteSpace was used to computationally analyze 433 articles, retrieved from Web of Science (WoS), published between 2001-2021, according to the following query: Query = (“Corporate foresight” OR “Strategical foresight” OR “Organizational foresight”). Based on this research problem three research questions were formulated:

RQ.1 How corporate foresight research has changed over the last two decades?

RQ.2 What is the intellectual structure of corporate foresight?

RQ.3 What are the current research trends in corporate foresight literature?

This study contains a literature review on corporate foresight, in chapter 2, followed by the methodology, in chapter 3, which shows the research design, and introduces the concept of bibliometric network analysis, data collection, and data analysis. Furthermore, in chapter 4 the results of descriptive analysis, bibliometric analysis, and clustering analysis will be displayed based on quantitative analysis and science mapping, as well as the discussion of the findings. Lastly, in chapter 5 the conclusion, limitations, and future paths.

2. Literature Review

This chapter will introduce the core concepts of corporate foresight based on existing literature, its impacts on firm performance, according to firm size, and its impacts on innovation, followed by the drawbacks of CF and lastly what was the past, what is the present and what is the future of CF according to researchers.

2.1. Corporate Foresight

The complexity of the business environment's nature by its inherent volatility is a cause of the widespread of technological innovations (Bereznoy, 2017). In parallel, the increase of uncertainty, in the business environments, increases the need to comprehend its dynamics, Rohrbeck et al. (2015), and a reconsideration of the nature and processes of strategic decision making (Vecchiato, 2015). Uncertainty is the incapability to forestall the expected progression of a driver of change in the business environment (Højland & Rohrbeck, 2018).

As stated by Battistella and De Toni (2011) "an organization is, in fact, a complex adaptive system that works depending on expectations and modifies its behavior as a consequence of learning from its environment, from competitors´ behavior, from the evolution of the industry". Environmental uncertainty ascends precisely when managers have a deficiency of information about the industry, competitors, and technological trends (Vecchiato, 2015).

Bereznoy (2017) mentioned that, during uncertainty, the conventional strategic approaches have become ineffective. Thus, there is a need to reassess the strategic decision-making process (Bereznoy, 2017; Battistella & De Toni, 2011; Vecchiato, 2015; Rotjanakorn et al., 2020).

Corporate foresight (CF) comes in as a key managerial competence to fight uncertainty (Kononiuk et al., 2017; Bereznoy, 2017; Schweitzer et al., 2019). CF revisions the weak signals and complexity of the business environment in a dynamic perspective to expand the outcome of the decision-making process (Battistella & De Toni, 2011).

As Öner and Beşer (2011) mentioned, foresight as a process has the advantage of being able to tolerate uncertainty and variety while also highlighting longer-term opportunities and threats.

2.1.1. Defining Corporate Foresight

In this section, we will present some of the definitions of CF available in academic research.

Daheim and Uerz (2006), who studied CF as a future intelligence-gathering process, mention that CF is used for strategic planning, R&D (Research and Development), innovation,

as well as corporate communications and company identity/branding. As decision-making in strategic planning and R&D has gotten more complicated and competition in the highly dynamic global information economy has increased, corporate foresight has become increasingly important whether in the shape of a long-term strategic vision, product innovation ideas, or a communication scenario (Daheim & Uerz, 2006). Likewise, Öner and Göl (2007) asserted that CF is based on the premise that the result of a company's activities requires long-term planning, or that it is done as a proactive measure to better deal with the complexities and uncertainties of the business environment in general.

Rohrbeck and Gemünden (2009), when exploring how companies use CF to enhance their ability to develop innovation, acknowledged that companies must build effective sensors to identify changes and guarantee that the detection results in managerial action. These capabilities are known as corporate foresight.

In addition, Battistella and De Toni (2011) proposed a methodology, "the methodology of future coverage", which measures how much the strategy oriented to future covers trends and megatrends, affirmed that CF offers genuine strategic value in assisting businesses to innovate and respond to the latent vulnerabilities of a rapidly changing and chaotic environment. The methodology of future coverage may be used as a managerial tool to motivate businesses to research and plan for a complicated and unpredictable future. Furthermore, Rohrbeck (2012), who studied CF as a value creation tool, detailed that CF can identify meaningful changes by scanning for market and technology trends; Spark innovation initiatives through processes, or by relying on R&D personnel insights to launch new R&D projects throughout and after the R&D lifecycle; Contribute to the demise of dominant mental models and set a deadline for determining if new mental models outperform old ones; Facilitate strategic dialogues with internal stakeholders through road-mapping workshops or scenario analysis; Support the transition away from path dependency by defining a vision for the future and mapping out the path to that goal; assist in the discovery, development and purchase of key resources through scouting networks. Also, Rohrbeck et al. (2015) accentuated the importance to tie CF perception and interpretation to value creation. The authors, Rohrbeck et al. (2015) emphasized that CF enables a company to set the groundwork for future competitive advantage. CF is the process of discovering, monitoring, and understanding variables that cause change, assessing potential organizational consequences, and initiating suitable organizational actions (Rohrbeck et al., 2015). CF includes numerous stakeholders and adds value by allowing access to essential resources ahead of the competition, preparing the company for a change, and allowing the firm to steer proactively toward a desired future (Rohrbeck et al., 2015).

Along, Vecchiato (2015) studied the value that companies produce via foresight in the face of increasing uncertainty due to the rapid speed of external change. The author, Vecchiato (2015), which does not differ strategic foresight from corporate foresight, defined strategic foresight as a set of procedures that companies employ to detect new events and changes in their external environment, investigate their expected evolution and impacts, and determine reaction courses. It, therefore, attempts to envisage alternative futures by sharply differing from prior future-oriented techniques such as forecasting because it is a continuous process in which businesses search for emerging occurrences that allow them to inform new strategic ideas regarding first-mover advantages and to update their initial views. Bereznoy (2017) studied CF as a new tool within the strategic management system of MNCs (Multinational Corporations). The author stated that CF denotes a coherent system of methods and organizational mechanisms that enable one to efficiently identify and thoroughly analyze the factors significantly affecting a firm, particularly radical changes in the business environment in the medium to long term, and plan responsive corporate actions to expected changes, agreed upon by key members of top management (Bereznoy, 2017).

Rohrbeck and Kum (2018) who emphasized the need for CF in a firms' future preparedness, stated that corporate foresight is used to assist businesses in breaking free from path dependency, assisting decision-makers in defining superior courses of action, and, eventually, enabling superior company performance. The authors also describe CF as a collection of activities that help companies to achieve a competitive advantage in future markets and that future readiness is calculated by contrasting the requirement for CF with the maturity of the focus firm's CF. Højland and Rohrbeck (2018) researched that CF should include activities that encompass both experimental and cognitive search elements. The authors, Højland and Rohrbeck (2018) conceptualized CF as a set of practices to perceive business innovation by identifying drivers of change, prospect and evaluate the repercussions of those drivers and to probe value propositions such as product/services and market acceptance.

Additionally, Schweitzer et al. (2019), who studied how organizations can implement customer foresight research, specified that CF helps businesses to predict what may occur in the future, by gathering resources on time, questioning traditional views on change strategy, and navigating an organization through uncertainty, such as new technology disruption. Customer foresight attempts to document how consumer demands and behavior may evolve in the future and then helps, based on those customer insights, to develop an appropriate organizational strategy. It is a source of competitive advantage because it identifies adoption and consumer lifestyle changes, as well as sources of growth for technological development. If

consumers participate in corporate foresight research it will enhance the validity of forecasting future consumer lifestyles and shorten reaction times.

2.1.2. Corporate Foresight on Firm's Performance

As mentioned, in times of discontinuous change, mainly driven by innovation, many companies find themselves at disadvantage. CF helps firms to adapt to the environment by anticipating change and breaking path dependencies. (Yoon et al., 2018; Calof et al., 2018; Rohrbeck & Kum, 2018). Many authors studied the impact of CF on organizations, MNCs, and SMEs (Small and Medium-sized Enterprises).

Authors Kononiuk et al. (2017), Milshina and Vishnevskiy (2018), and Gordon et al. (2020) exploit the differences of CF in both types of companies. Kononiuk et al. (2017) stated that deviations between the ownership systems, the procedures underlying the companies, and the resources drive the similarities and differences of corporate foresight, applied to MNCs, and SMEs. Foresight activities are mostly conducted in MNCs rather than SMEs, due to resource consumption (time, capital, and labor). Usually, SMEs cannot allocate resources to mature their long-term strategies (Kononiuk et al., 2017; Milshina & Vishnevskiy, 2018; Gordon et al., 2020). Furthermore, the authors Kononiuk et al. (2017) mention that SMEs usually operate in a microenvironment (customers, suppliers, competitors…) type of setting diminishing their external risk, as in contrary to MNCs that are more exposed to external risks since they operate and analyze the macro environment, the core focus of foresight activities. Additionally, foresight activities identify trends and drivers of change in the long run. SMEs do not plan for the long-term rather they focus on short-term objectives, such as tangible R&D of products and technologies to satisfy specific market needs (Kononiuk et al., 2017; Milshina & Vishnevskiy, 2018; and Gordon et al., 2020).

Kononiuk et al. (2017) also mention that the companies' motivation is a fundamental factor when applying foresight activities. SMEs want to enhance their innovation level within the company and large companies have internal and external reasons to increase competitiveness and strengthen the company market position. Although, since they operate in a microenvironment approach, have less need to focus on long-term environmental change. For Milshina and Vishnevskiy (2018) since SMEs have resource limitations, they should collaboratively implement foresight strategies to plan for the future. Collaboration allows to reduce resources and stimulates knowledge and networking.

According to Bereznoy (2017), corporate foresight is a key strategical instrument for MNCs, multinational corporations, because, as previously mentioned, the rapid change of the

business environment cannot be fully covered by corporate strategic management and thus, the growth of long-term future-oriented responses. Bereznoy (2017) mentions that in a high complexity business environment, the company processes are scoped for the long-term and there is a multi-level integration in the company. Additionally, Bereznoy (2017) stated that in high dynamics environments, the company processes are flexible, have a short duration and the main goal is to respond quickly to the unpredictability of the market. Thus, the company focus on the factors that drive radical changes.

Furthermore, Bereznoy (2017) stated that the main reason for MNCs applying corporate foresight approaches is intrinsically related to the goal of having an "early warning system" capable of identifying in advance competitors' threats and emerging market opportunities.

Nonetheless, Milshina and Vishnevskiy (2018) affirmed that in a rapidly changing environment any innovative business needs the best information available to set on a strategy that can optimize its technological plans. In accordance, Rohrbeck and Kum (2018) produced strong evidence that future prepared companies increase the likelihood of outperforming their peers, as much as 33% higher profitability and 200% market capitalization.

2.1.3. Corporate Foresight on Innovation

In the CF research literature, a mutual theoretical inclination, among authors, can be recognized. Multiple authors mentioned a positive connection between corporate foresight and innovation management and these managerial fields, together, stimulate knowledge, product development, technology progress, disruptive changes, value creation, and long-term performance (von der Gracht et al., 2010; Rohrbeck & Gemünden, 2011; Rohrbeck, 2012; Hines & Gold, 2015; Adegbile et al., 2017; Yoon et al., 2018).

However, Yoon et al. (2018) stated that CF and innovation still depend on the organizational learning engagement, such as investing in new ideas and problem-solving initiatives, whether they are related to products, services, or processes: "Organizations that employ more corporate foresight exercises are more likely to be engaged in learning and, therefore, have a higher propensity to enact innovation." (Yoon et al., 2018).

Rohrbeck and Gemünden (2011) identified that CF is a protagonist in maximizing the innovation capacity of a firm. The authors Rohrbeck and Gemünden (2011) mention that corporate foresight must explore new business fields, as well as, needs to expand the number of innovative concepts and it is required to increase the quality of the output of the innovation. Hence, the authors Rohrbeck and Gemünden (2009) and Rohrbeck and Gemünden (2011), in both research, mentioned three roles that CF should play to maximize the innovation capacity

of a firm:

- *The "strategist role"* – According to Rohrbeck and Gemünden (2009) and Rohrbeck & Gemünden (2011) in the strategist role, innovation is steered, by CF, through corporate vision (common goals & future products that direct thinking and working); strategic management (need for strategic alliances to build value creation networks); knowledge (internal stakeholders opinion on the probability of trends, size of business opportunities and market forecast); evaluate and relocate current R&D portfolios (as opportunities are identified they should be in alignment with R&D priorities and budgets); identifying business trends and business models (what might threaten the current business model?).
- *The "initiator role"* – As stated by Rohrbeck and Gemünden (2009) and Rohrbeck and Gemünden (2011), in the initiator role, innovation is triggered, by CF, through the identification of product and services trends in the market, new customer needs, and technologies. This role scans the environment and feeds the innovation tunnel, and consequently expanding the innovative output both qualitatively and quantitatively.
- *The "opponent role"* - As detailed by Rohrbeck and Gemünden (2009) and Rohrbeck and Gemünden (2011), in the opponent role, innovators are challenged, by CF, through stimulating and monitoring their assumptions (challenge innovators ideas, technological developments, and regulatory issues), that are built on the business environment. By doing this, the innovators can readjust their innovation activities and reduce the risk of project failures; Through challenging R&D projects to ensure its state-of-the-art of current activities with what was scanned in the business environment and operationalized in lead markets; Finally, identifying external disruptions, such as alternative or substitute products and services, that can compromise the firm's technology by satisfying or changing customer's needs.

According to Adegbile et al. (2017) corporate foresight does not result in innovation. On the contrary, it tends to influence innovation by giving form to innovation management tools and future-oriented knowledge creation and providing information and thus driving innovation performance (Adegbile et al., 2017).

2.1.4. Pitfalls and Barriers of Corporate Foresight

Hines and Gold (2015) provide comprehensive research about the foresight barriers to innovation based on a literature review on corporate foresight. The first barrier that the author mentions are that foresight strives for recognition meaning that companies already have their view of how the environment works or are focused on what they are doing and therefore they

prefer to stay grounded to their perceived ideas and solutions. The second barrier is that foresight is seen negatively because it can disrupt companies' routines. The third barrier is that foresight is seen as a non-tangible quality since studying the future is perceived as an idyllical intellectual activity. Finally, the fourth barrier is firms' capacity for foresight is inadequate, meaning more work is necessary to be implemented compared to a forecasting approach, and thus, in corporations, foresight is often episodic (Hines & Gold, 2015).

Öner and Göl (2007) stated that more effective foresight project results would be possible if the detailed pitfalls of each project stage were identified and considered in a more systemic and integrated way. Therefore, the authors Öner and Göl (2007) provide an extended framework, based on Anderson et al. (1996) framework, that considers 6 pitfalls of assessing corporate foresight as a project:

1. "Pitfalls in the foundation of corporate foresight projects" – in this phase, it is detailed corporate foresight executer´s attitude, preliminary work, purpose, and needs (Öner & Göl, 2007; Öner & Beşer, 2011).
2. "Pitfalls in the planning of the corporate foresight projects" – in this phase, specifications are outlined as well problem-solving guidelines. The flaws might be the asymmetry of planning; the planning tools; planning range; planning method (Öner & Göl, 2007; Öner & Beşer, 2011).
3. "Pitfalls in the organization of the corporate foresight projects" – the structure includes a steering committee, project manager, and project team. The flaws might be alternative organizations for the project are not considered; the distribution of responsibility is not defined; key resources are not available when required (Öner & Göl, 2007; Öner & Beşer, 2011).
4. "Pitfalls in the control of the corporate foresight projects" – it is the reporting process of the defined plan. The flaws might be understanding the purpose of control and the difference between monitoring and control (Öner & Göl, 2007; Öner & Beşer, 2011).
5. "Pitfalls in the execution of the corporate foresight projects" – the most important phase of corporate foresight. The flaws might be the complexity of coordinating a variety of resources, changes to the defined plan (Öner & Göl, 2007; Öner & Beşer, 2011).
6. "Pitfalls in the feedback and continuity of foresight project" – this stage is crucial for a better evaluation of corporate foresight, as well as their dissemination within and outside the organizations (Öner & Göl, 2007; Öner & Beşer, S. G., 2011).

Furthermore, Dadkhah et al. 2018 stated that the multidimensional definition of CF makes it hard to use foresight on the corporate level, due to the fact, that at the corporate level success

is measured through performance (financial, market share, productivity…) and companies have many projects at the same time, each one with different criteria of success. Additionally, Milshina and Vishnevskiy (2018) mentioned that some barriers to the CF of SMEs are the low financial resources, human and time, low incentives to anticipate the future, and the high risks of development. For MNCs, although may have the same barriers some may have the risk of changing what is already a diverse portfolio.

2.2. Corporate Foresight: The Past, The Present, and The Future

2.2.1. Overview on Corporate Foresight Past

In the 1950s, CF emerged as a research stream by the hands of Gaston Berger, "prospective school", and by Hermann Kahn, "foresight school", motivated by the world's acceleration and uncertainty of not knowing the future (Rohrbeck et al., 2015).

Berger conceptualized foresight as a school of thoughts centered around the idea of building scenarios – visions about a desired future – by enabling collaborative thinking, future-oriented sensemaking, and collaborative decision-making involving decision-makers in later stages of strategic management (Rohrbeck et al., 2015). Kahn conceptualized foresight as a research stream centered around future anticipation methods such as the Delphi technique, less decision-making, and more expert opinions consolidation (Rohrbeck et al., 2015). The research stream involved along the following years with newer techniques emerging, such as scenario analysis and technology road mapping techniques.

Inline, various authors mentioned that, in the past, CF had two types of phases: expert-based foresight and model-based foresight. Daheim and Uerz (20069, Daheim and Uerz (2008), and von der Gracht et al., (2010) mentioned that in expert-based foresight the dominant proposition is that the future can be foreseen by collecting the views of experts.

Knowledge is acquired by outsourcing foresight activities to field connoisseurs, such as research institutes. However, issues like failing to keep sight of the proposed outcomes, settling on dependency, can lead to underestimating future strategic decisions. von der Gracht et al., (2010), Daheim and Uerz (2008), and Daheim and Uerz (2006) also studied model-based foresight and conceptualized it as quantitative approaches to calculate the future based on data and information collection.

The so-called "planning school", mainly embodied by Michael Porter, the founder of the modern strategy field (Harvard Business School, 2021), and Harry Igor Ansoff, the prominent reference on strategic management (Martinet, 2010), dominated the managerial field of study

(Bereznoy, 2017; Battistella & De Toni, 2011). The planning school, regarding uncertainty, proposed to deal with it by systematically analyzing and planning the business environments by scanning the periphery, monitoring trends, detecting weak signals, generating forecasts, and integrating all the information collected in the decision-making process to develop strong strategic options (Bereznoy, 2017; Battistella & De Toni, 2011; Vecchiato, 2015; Vecchiato et al., 2020). Vecchiato (2015) and Vecchiato et al. (2020) stated that this diligent information collection process allows companies to predict changes, especially technological changes, and eventually outperform their peers. Thus, acquiring and maintaining competitive advantage positions, particularly in a turbulent context (Battistella & De Toni, 2011).

This managerial theory recognizes that predictions are not faultless because they are associated with higher levels of difficulty. However, predictions still are a vital tool to align companies and the environment by allowing decision-makers to identify market opportunities and threats and thus act quickly upon them, gaining first-mover advantages, such as the learning curve and customers switching costs (Vecchiato, 2015; Vecchiato et al., 2020).

Vecchiato et al. (2020) mention that several frameworks have been developed to cope with uncertainty like innovation risk management frameworks. However, Vecchiato (2015), mentioned that companies are strained to make decisions under "*bounded rationality*" circumstances, meaning that companies and their managers are not capable to gather, process, and understand information about changes and new events that occur externally to their environments (Vecchiato, 2015). Furthermore, eventually, it leads to diminishing predictability of upcoming changes (Muhlroth & Grottke, 2020).

Bereznoy (2017) mentioned that the "planning school" recognized the existing forecasting methodologies were imperfect and limited but also believed that they were the best available techniques for understanding the business environment uncertainty. Thus, hypothesizing that the firms that are better organized to analyze the environment and forecast the environmental changes and trends should gain competitive advantages.

Furthermore, the author Bereznoy (2017) points out a clear vision of the issues with this school. Bereznoy (2017) asserted that "theory has followed practice striving to suggest a theoretical justification of approaches already discovered by practicing managers", meaning that in this research stream the outcomes of a firm's strategies were meant to develop theories and justify them. Thus, the increasing criticism in academic literature regarding uncertainty management.

2.2.2. Overview on Corporate Foresight Present

The criticisms of the "planning school" were the foundation of the "learning school" (Daheim & Uerz, 2006; Vecchiato, 2015; Bereznoy, 2017; Vecchiato et al., 2020). This new managerial perspective completely rejects the bases of the planning school, systemic analysis, and planning regarding uncertainty, because of the impossibility to make reliable predictions (Bereznoy, 2017; Vecchiato, 2015).

In contrary to the planning school, the learning school proposes that prediction should be avoided, and instead uncertainty should be managed as changing events occur (Vecchiato, 2015 and Vecchiato et al., 2020). The learning school suggests that those who can minimize the use of predictive rationality, foreseeing, can benefit from late-mover advantages that exceed the first-mover advantages (Vecchiato et al., 2020).

Bereznoy (2017) mentions that since the beginning of the twenty century, corporate foresight took a leading role in advanced theoretical thinking on environmental uncertainty management integrated into strategic decision-making. von der Gracht et al. (2010), mentions that the transition from a traditional industry-driven economy to a knowledge-based economy requires new theoretical conceptualization, as well as, procedures to ensure sustainable competitive advantages in the managerial world, thus corporate foresight and innovation are key success factors.

For that reason, some authors, Daheim and Uerz (2006), Daheim and Uerz (2008), and von der Gracht et al. (2010) suggested that currently, we are in the third phase of corporate foresight the trend-based foresight. They stated that the dominant logic is that there is the assumption that businesses can comprehend the future by anticipating the impact of trends on customers, through environment scanning and monitoring. However, an issue can emerge businesses, by concentrating their focus on scanning and monitoring trends, lose reaction, meaning that, if an event occurs in the environment, the company is limited to setting a reactive strategy (von der Gracht et al., 2010).

2.2.3. Overview on Corporate Foresight Future

In the research stream of corporate foresight, it is clear among theorists that CF has limitations. Open foresight (OF) is a new foresight approach that is being studied to cope with the CF limitations and it is classified as the next phase of foresight: "context-based foresight" (Daheim & Uerz, 2006; Daheim & Uerz, 2008; von der Gracht et al., 2010; Wiener, 2018; Wiener et al., 2020).

Wiener and Boer (2019) stated that it is getting more difficult for companies to master the

increasing complexity and dynamics of the environments by relying exclusively on internal capabilities. Therefore, companies are forced to collaborate through strategic alliances and partnerships.

Open foresight is an approach that pushes companies to jointly investigate the future, (Wiener, 2018), and it is characterized by transparency, methodological hybridity, context orientation, and participation (von der Gracht et al., 2010). In OF, it is not necessary to build new solutions based on trends, but rather to motivate people to look beyond trends since developing challenges or technologies, as well as weak signal monitoring, are critical in environmental and horizon scanning operations (Daheim & Uerz, 2008).

The definition of open foresight ranges from an open approach, (Ehls et al., 2017), to networked foresight (Heger & Boman, 2015). Heger and Boman (2015) defined "networked foresight" as "foresight conducted in innovation networks for the benefit of the network and its partners with active contributions from the partners". Fundamentally, according to Heger and Boman (2015), corporate foresight and networked foresight are similar with the difference that networked foresight is carried out in inter-organizational innovation networks with active network partner participation and for the benefit of network partners and the network itself.

According to Wiener and Boer (2019), for OF to be successful, companies must have a strong absorptive capacity and should focus on stakeholder integration. In addition to that, companies should have an open-minded culture to integrate external knowledge into their innovation and foresight processes.

Open foresight goal is to reduce future uncertainty by designing and evaluating future business strategies through cooperative scenario mapping, action plans, and innovation in an open relationship with the business environment (Wiener, 2018). Wiener (2018) also mentions that an organization that supports flexibility and, heterogeneous teams (different departments, ages, genders), encourages top management risk-taking, and resources sharing, such as budget time and people, is set to foster OF practices. However, Wiener (2018) research proves that in OF activities top managers should avoid team participants from different managerial levels to avoid decision-overtaking.

For this reason, Kononiuk et al. (2017) specified that openness to foresight is a managerial competence and a dynamic capability for foresight capacity enlargement within the company.

Furthermore, (Daheim and Uerz, 2008) mention that OF assumes that business may create the future by predicting the dynamic interconnections of social, technical, and economic factors through open communication. It is linked to the increasing socio-cultural and socio-technical dynamic that has resulted from the creation of the networked society, in which nearly

everything is interrelated and the division of domains of existence, such as technology, economics, politics, and culture, has ended (Daheim & Uerz, 2008). The author, Daheim and Uerz (2008), also detailed that since open innovation asks for the inclusion of lead users in the innovation process (new product and services) that better match the demands of customers, OF can lower R&D costs and failures. Therefore, OF is based on communication and discussion to foster future strategies by involving and collaborating with internal and external stakeholders and it should be intellectualized as an open process that ends when an outcome is attained. (Daheim & Uerz, 2008)

Wiener et al. (2020) said that collaborative OF encourages incumbents to think outside the box, breaks away from route dependency, leads to a more proactive approach, and stimulates strategic debates because the risk of being limited to the existing mental models is reduced and increases aiding in the creation of more completed depictions of the opportunities and risks offered by disruptive shifts.

Von der Gracht et al. (2010), when studying how fit is a company for the future, stated that the "future-fittest" companies are the ones that succeed in the knowledge economy and "fit" in CF and innovation management, are the ones that integrate and follow open network innovation, where various stakeholders are integrated into the innovation process (idealization to technology development and market), and open foresight to face the challenges of the future.

3. Methodology

In this chapter, we present the research context, the research design, the process of data collection, and data analysis.

3.1. Research Context

According to Chen (2016), a knowledge domain is a broad concept that encompasses the idea of a logically and cohesively organized body of knowledge. CiteSpace helps researchers organize research field knowledge. CiteSpace is a free, Java-based, computer program for visualizing and analyzing literature in a scientific domain.

It runs on bibliographic information, from the Web of Science, Scopus amongst others, and generates interactive visualization patterns to understand scientific literature and uncover research trends on a specific topic.

There are several software' or applications to perform bibliometric analysis, such as VOSviewer, BibExcel, etc. We decided to use CiteSpace, not only because of the power analysis but also because it reports more statistics, is configured according to each researcher's needs, and, thus better suited to take computative and quantitative results.

CiteSpace was created in 2004 and allows researchers and enthusiasts to visualize and analyze trends and patterns in scientific literature. CiteSpace processes data into network patterns and helps identify thriving topical areas, novel research patterns by decomposing the network into clusters supported by temporal analyses (CiteSpace, 2021). It succors collaboration networks, author co-citation networks, and document co-citation networks investigations.

The networks developed in CiteSpace consist of nodes, that represent the types of entities (e.g., authors, journals, and references) and links that represent the relationship between the nodes (Zhai et al., 2021).

Studies such as Zhang et al. (2020), Zhai et al. (2021), and Amini et al. (2021) have used CiteSpace to conduct their analyses.

In CF research only a handful of articles are literature review or state-of-the-art, such as Daheim and Uerz (2006), Rohrbeck et al. (2015), Adegbile et al. (2017), Iden et al. (2017) and Gordon et al. (2020). Only two articles are a bibliometric analysis: Gibson et al. (2018) that studies technology foresight literature and Amini et al. (2021) that studies regional foresight.

3.2. Research Design

This study followed a computational approach. Regarding the type of investigation this paper trails a bibliometric analysis, combining both quantitative analysis (evaluation and interpretation) and qualitative analysis (interpretation only).

3.2.1. Bibliometric Analysis

According to Han et al. (2020), a bibliometric network analysis intends to provide the reader comprehensive understanding and intellectual trends for future research, by analyzing all related publications in a certain field of study. Bibliometric network analysis aims to study the research landscape, discuss common research topics and the future direction (Han et al., 2020).

A bibliometric analysis studies the relational information on a specific topic, using quantitative, objective, and computational analysis (Han et al., 2020, Zhai et al., 2021). As stated by Gibson et al., (2018), bibliometrics is used to analyze research elements such as citation, authors, and semantics using graphic elements to present the data in the form of a network map (nodes).

In contrary to a systematic literature review that studies a limited number of reviewed studies, to implement content analysis, Han et al. (2020), and are manually intensive, qualitative, and subjective, thereby, prone to bias (Zhai et al., 2021).

Inline, according to Donthu et al. (2021), the difference between a bibliometric analysis and a systematic literature review is that a bibliometric analysis summarizes huge amounts of bibliometric data to illustrate the state of the art and structure of a research stream and its rising trends, and a systematic literature review synthesizes the findings of the previous study on a certain research subject or field.

3.2.1.1. Bibliometric Analysis Main Techniques

There are several types of networks such as co-authorship network (node = author), co-authors' institutions network (node = institution), co-authors' countries network (node = country), co-occuring phrases network (node = term), co-occuring author keywords network (node = keyword), co-ocurring subject categories (node = category), document co-citation network (node = reference), author co-citation network (node = cited author) and journal co-citation network (cited journal). The metrics used to evaluate each network's node are:

- *Degree of Centrality:* it is the number of the relational ties of a node within a network (Donthu et al., 2021). For example, if the node is an author, the degree of centrality is

the number of authors with whom one author worked.

- *Betweenness Centrality:* According to Chen et al. (2010), each node in a network has its betweenness centrality metric. It varies from 0 to 1 (CiteSpace101, 2021-a). It determines how close the node is to be in the center of a path that links other nodes in the network as it measures the probability that a node is on the shortest path in the network (Chen, 2005). Chen (2006) mentions that high betweenness centrality ratings suggest potentially revolutionary scientific articles as well as gatekeepers, responsible articles, or authors for innovation, in networks.
- *Burstness:* Concerning the burstness of an item (reference, author, keyword, journal…), the burst value evaluates if a particular frequency function exhibits statistically significant changes over a brief time interval within a larger time frame. Citation analysis can use burstness to determine whether and when the citation count of a certain reference has increased (Chen et al., 2010).
- *Sigma:* The sigma value (∑), represents a measure of scientific innovation, novelty. It selects scientific publications that are likely to contain innovative ideas based on two transformative discovery criteria, centrality, and burstiness - $(centrality\ +1)^{burstness}$ - (Chen et al., 2010). According to Gaggero et al. (2020), it measures the combined strength of structural and temporal properties of a node, namely, its betweenness centrality and citation burst. Higher sigma values often signify greater creativity, innovativeness, and influence (Zhang et al., 2020). In the current research, we set sigma>1.5 to represent the possible originality, innovation, and influence of a topic.

Furthermore, each network can be divided into clusters. The division of the network into groups of individual nodes is called clustering, being those groups called clusters (Chen, 2016). There are two types of clustering approaches hard clustering approach (nonoverlapping clusters) and the soft clustering approach (overlapping clusters).

According to Chen et al. (2010), using nonoverlapping clusters allows differentiating the clusters' nature, being more efficient than using overlapping ones. The same authors also mention that the spectral clustering method is an efficient, uniform, and generic method of clustering that uses standard linear algebra to solve clustering problems and simplifies subsequent labeling procedures.

Cluster labeling is an algorithm-based approach that employs index words or terms from the article titles and abstracts of each cluster (Chen et al., 2010). Clusters are automatically labeled by the selection of noun phrases and index terms of the cited publications in each cluster (Chen et al, 2010). These terms are ranked by three different algorithms: Log-Likelihood Ratio

(LLR), Latent Semantic Indexing (LSI), and Mutual Information (MI). LLR and MI tend to represent a distinctive feature of a cluster (Chen et al, 2010).

Moreover, there are cluster metrics that allow detecting the overall structure of the networks, such as Modularity Q and Silhouette Metric (Gaggero, 2020):

- *Modularity Q:* Regarding the modularity Q of a network, Chen et al. (2010) mentioned that it is the degree to which it can be split into independent blocks. According to Chen et al. (2010), the modularity score ranges between 0 and 1. A network with low modularity, closest to 0, cannot be reduced to clusters with defined boundaries, whereas a network with high modularity, may be well structured, meaning that it can be reduced to clusters. However, Chen et al. (2010), also stated that the closest to 1 more cluster will be isolated, dispersing the network.
- *Silhouette:* The silhouette metric can be used to estimate the uncertainty in determining the nature of a cluster (Rousseeuw, 1987). Chen et al. (2010) specified that the silhouette value, which ranges from -1 to 1, shows the degree of uncertainty that must be considered while understanding the nature of the cluster. A value of 1 denotes complete isolation from other clusters, which represents an easier way to label the clusters (Chen et al., 2010).

The cluster metrics are also a good indicator to choose the best node selection criteria. The most used node selection criteria are:

- *G-Index* - g-index is the (unique) greatest number (in which articles are ordered in decreasing order of the number of citations they got) such that the top g articles got (collectively) at least g^2 citations (Egghe, 2006). The number of citations in an author's most important articles is factored into the g-index. The highest number that equals the average number of citations of the most highly referenced g publications is the g-index. CiteSpace employs a modified g-index with a scaling factor k to make it even more versatile. The k parameter can be any positive value, allowing the user to tailor the total size of the resulting network to their requirements (CiteSpace101, 2021-b).
- *Top N* - this criterion selects the N articles that were most cited and utilizes data from them to build the network for each time slice (Gaggero et al., 2010).
- *Top N%* - this criterion selects the N% articles that were most cited and utilizes data from them to build the network for each time slice (Gaggero et al., 2010).

3.3. Data Collection

Data was collected from the Web of Science Core Collection which is the premier resource on the Web of Science and the world's most trusted citation index for scientific and scholarly research. This collection is comprised of 21,000 peer-revied journals published worldwide in over 250 disciplines (Clarivate.libguides, 2021). Based on the research framework and review studies, such as Daheim and Uerz (2008), Rohrbeck et al. (2015), and Gordon et al. (2020) the following query was built and searched on WoS: *Query* = ("Corporate foresight" OR "Strategical foresight" OR "Organizational foresight"). The period was set between 2000 to 2021. From this query, the initial result was 435 publications. Since there are zero papers from 2000, the final timespan was set, 2001-2021. This time frame was selected because it allows a deep interpretation of the past two decades of the research stream.

Furthermore, no language barrier was implemented. It was decided that all publications: English, Russian publications, German publications, French publications, Spanish publications, and Portuguese should not be excluded from the analysis. Not only CiteSpace has the computational power to analyze different languages, but also all papers have, at least, a title and abstract in English. For the research, poetry and letters were filtered out which culminated in 433 results (346 articles, 65 proceeding papers, 19 review articles, 13 editorial materials, 8 early access, and 6 book reviews). The objective of filtering the data was to improve effectiveness in data processing, analyzing, and interpreting. The data, composed of 433 publications, was exported on 09/11/2021 as a plain text file (.txt) with full records and Cited references (see Appendix A). However, it should be mentioned that from the 433 articles, which represent the initial sample (n=433), CiteSpace removed from all the bibliometric analysis 5 studies, which left us with 428 eligible articles.

3.4. Data Analysis

In this section, we describe the procedure that was followed in this study. We divided our analysis into two parts: descriptive analysis and bibliometric analysis.

We started by conducting a descriptive analysis of publication frequency over time and a descriptive analysis of citations frequency over time, both based on the WoS data, meaning that they were based on the initial sample with N=433. This will allow us to answer the first research question, RQ.1 - How corporate foresight research has changed over the last two decades? – and thus understanding how CF evolved in the past few decades. Next, a descriptive analysis, based on WoS data of the top 10 journals per publications and citations, the top 10 authors per

publications and citations, the top 40 most used keywords (author keywords and keywords plus), and finally the top 10 most cited publications was conducted. These descriptive analyses, allowed us to understand how the CF domain is structured, which was our RQ.2 - What is the intellectual structure of corporate foresight? We used WoS data for all descriptive analyses because we wanted to get a deeper understanding of the data before applying the selection criteria (g-index) in the bibliometrics.

Subsequently, a bibliometric analysis, using CiteSpace, was conducted with the generation of networks for journals, authors, keywords, and publications. In this analysis, we show a visualization of the networks as well as the main metrics: frequency, degree of centrality, betweenness centrality, burstness, and sigma value, all used to evaluate how each networked and thus acknowledge specific network trends. All the bibliometric analyses and clustering were produced using the g-index selection criteria. In CiteSpace, when proceeding with the bibliometrics a g-index was calculated automatically for each temporal slice (one slice equals one year). The K=25, as mentioned in chapter 3, was the scaling factor used to reduce or increase the number of nodes, the closest to 1 the higher the number of nodes in each network.

In the journals' bibliometric analysis, applying the g-index with k=25, increased the number of studied journals. The initial 428 papers were published in 191 journals and by applying the selection criteria method the data increased to 589 journals (nodes). In the authors' bibliometric network, when we applied the g-index with k =25, the number of authors studied decreased from 1043 authors to 594 authors (nodes). In the keywords, bibliometric network, applying the g-index reduces the number of studied keywords (author keywords and keywords plus), from 1630 to 312 keywords (nodes). In the document co-citation bibliometric analysis, applying the g-index k=25, increased the number of studied publications, from 428 to 663. Moreover, to continue to understand what the current trends on CF are, we did a clustering analysis on the publications using the labeling method LLR (log-Likelihood ratio).

Considering that we wanted to focus our attention on the current trends, we selected the clusters that had recent activity, meaning the ones that had publications in 2020 or 2021. After selecting the clusters, we then focus our attention on the publications that had burst periods covering 2021. This allowed us to do a qualitative analysis on the content of the main publications within the clusters.

Looking into the bibliometric metrics and the clustering analysis will allowed us to answer the final research question, RQ.3, and thus acknowledge the latest research trends on CF literature. It should be noticed that for the descriptives and bibliometrics no difference was made between journals, conference proceedings, or scientific books.

4. Results and Discussion

In this chapter, we will present the results of our analysis and the discussion of those results.

4.1. Results

This section exhibits the results of this study, to validate and answer the research questions formulated in chapter 1 and it is divided into descriptive analysis and bibliometric analysis.

4.1.1. Descriptive Analysis

This section presents some descriptive analyses: the publication frequency and citation frequency of CF literature, followed by a journal, authors, keywords, and document analysis.

4.1.1.1. Publication Frequency

Figure 4.1 shows that, since 2001, the number of publications, regarding corporate foresight has gradually increased and 85,68% of the publications were published after 2010. Furthermore, it is possible to visualize that, in 2001, there was only 1 publication and, in 2015, the number of publications reached a peak of 56.

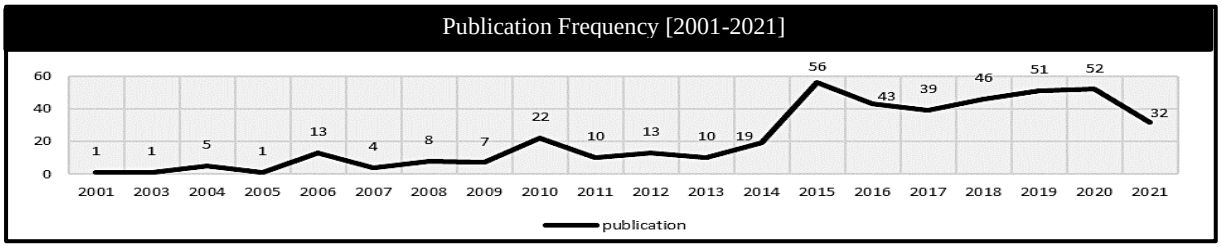

Figure 4.1 - Query Publication Frequency [2001-2021] (Own source)

4.1.1.2. Citation Frequency

Figure 4.2 presents the number of citations per year for all the 433 articles that composed the data between 2001 and 2021. In total 5670 citations occurred during the studied period. It is possible to identify two citation peaks: one in 2010, with 896 citations, and another in 2015, with 925 citations. Moreover, 71,26% of the citations occurred after 2010. In contrast, it is possible to observe that the overall citation frequency is decreasing since 2015.

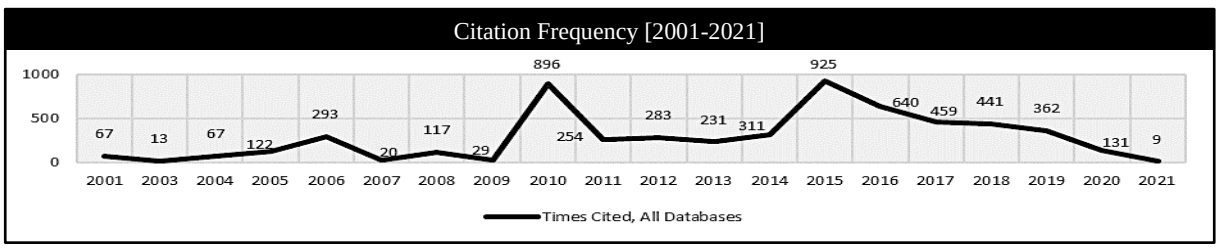

Figure 4.2 - Query Citation Frequency [2001-2021] (Own source)

4.1.1.3. Journal Co-citation Descriptive

The 433 papers were published in 191 different journals and 154 of those journals only published one paper. In contrast, the 10 journals with more publications accounted for 50,5% of the total publications, see Table 4.1.

Table 4.1 - Number of publications per journal [2011-2021] (Own Source)

Rank	Journal Name	Publications [2001-2021]	% of 433	Acc. % of 433
1st	Technology Forecasting and Social Change	78	18,01%	18,01%
2nd	Futures	50	11,55%	29,56%
3rd	Foresight	28	6,47%	36,03%
4th	Technology Analysis & Strategic Management	15	3,46%	39,49%
5th	European Journal of Futures Research	13	3,00%	42,49%
6th	Journal of Futures Studies	8	1,85%	44,34%
7th	Global food Security-Agriculture Policy Economics and Environment	7	1,62%	45,96%
8th	Foresight and STI Governance	7	1,62%	47,58%
9th	Technology Innovation Management Review	7	1,62%	49,19%
10th	Futurist	6	1,39%	50,58%

As presented in Table 4.1, Technology Forecasting and Social Change journal lead the ranking with 78 studies published (18,01%), Futures journal comes in second with 50 studies published (11.5%), Foresight journal comes in third with 28 publications (6.4%), Technology Analysis & Strategic Management comes in fourth with 15 publications (3.46%), European Journal of Futures Research comes in fifth with 13 publications (3,00%). Journal of Future Studies, Global Food Security – Agriculture Policy Economics and Environment, Foresight and STI Governance and Technology Innovation Management Review and Futurist Journal represents together 6,71%. Table 4.2 shows the top 10 journals based on their citation count.

Table 4.2 - Number of citations per journal [2011-2021] (Own Source)

Rank	Journal Name	Citation Count [2001-2021]	% of 5670	Acc. % of 5670
1st	Technological Forecasting and Social Change	2216	39,08%	39,08%
2nd	Futures	766	13,51%	52,59%
3rd	Nature Climate Change	296	5,22%	57,81%
4th	Technology Analysis & Strategic Management	201	3,54%	61,36%
5th	Global Change Biology	144	2,54%	63,90%
6th	Foresight	123	2,17%	66,07%
7th	Marketing Science	122	2,15%	68,22%
8th	Global Food Security-Agriculture Policy Economics and Environment	89	1,57%	69,79%
9th	Conservation Letters	82	1,45%	71,23%
10th	R&D Management	78	1,38%	72,61%

As presented in Table 4.2, the 10 most cited journals from 5670 total citations, Technology Forecasting, and Social Change is ranked first with 2216 citations, followed by Futures journal with 766 citations, Nature Climate Change with 296, Technology Analysis & Strategic Management journal with 201, Global Change Biology with 144, Foresight with 123, Marketing Science with 122 citations, Global Food Security-Agriculture Policy Economics and Environment with 89, Conservation Letters with 82 and finally R&D Management with 78 citation counts. The top 10 journals with more citations accounted for 72,61% of the total citations.

4.1.1.4. Author Co-citation Descriptive

The 433 studies used on the dataset were published by 1043 distinct authors. In the following table, Table 4.3, is possible to see the most productive authors: René Rohrbeck is in first place with 17 record counts meaning that he contributed to 3.93% of the 433 studies, as the main author or as a secondary one, followed by David Sarpong with 12 record counts (2.77%), Daniel Mason-d'croz and Dirk Meissner both with 10 record counts (2,31%), Konstantin Vishnevskiy with 9 records (2,08), Melanie Wiener with 8 records (1,85%), Riccardo Vecchiato with 7 records (1,62%), Senthold Asseng with 6 records (1,39%), followed by 6 authors with 5 records each (1,15%) and 18 authors with 4 records each (0,92%). In the column Acc % of 433, we can see that 41,8% (181 publications) of the 433 published papers were produced by 32 authors.

Table 4.3 - Number of publications per author [2011-2021] (Own Source)

Rank	Author Name	Publications [2001-2021]	% of 433	Acc. % of 433
1st	René Rohrbeck	17	3,93%	3,93%
2nd	David Sarpong	12	2,77%	6,70%
3rd	Daniel Mason-d'croz	10	2,31%	9,01%
4th	Dirk Meissner	10	2,31%	11,32%
5th	Konstantin Vishnevskiy	9	2,08%	13,39%
6th	Melanie Wiener	8	1,85%	15,24%
7th	Riccardo Vecchiato	7	1,62%	16,86%
8th	Senthold Asseng	6	1,39%	18,24%
9th	Sika Gbegbelegbe; Jari Kaivo-Oja; Anna Kononiuk; Pierre Martre; Richard D. Robertson; Heiko A.von der Gracht	5	1,15% (6,93%)	25,17%
10th	Cinzia Battistella; Frank Ewert; Regina Gattringer; Guy Hareau; Gerritt Hoogenboom; Oleg Karasev; Kurt-Christian Kersebaum; Mairi Maclean; Matthew P. Reynolds; Sherman Robinson; Alex Ruane; Jan Oliver Schwarz; Mikhail A. Semenov; William J. Sutherland; Victor Tiberius; Julia Rose West; Keith Wiebe; Joost Wolf	4	0,92% (16,63%)	41,80%

In Table 4.4, it is possible to see the most cited authors from a total of 38350 co-citations. René Rohrbeck is in first place with 674 citations from all the 17 papers that he participated in, followed by Senthold Asseng with 441 citations, Gerrit Hoogenboom and Joost Wolf with 389 citations each, and so on. In total from the top 10 most cited authors represent 10,65% of the total number of co-citations.

Table 4.4 - Number of citations per author [2011-2021] (Own Source)

Rank	Author Name	Citations [2001-2021]	% of 38360	Acc. % of 38360
1st	René Rohrbeck	674	1,76%	1,76%
2nd	Senthold Asseng	441	1,15%	2,91%
3rd	Gerrit Hoogenboom	389	1,01%	3,92%
4th	Joost Wolf	389	1,01%	4,93%
5th	Davide Cammarano	372	0,97%	5,90%
6th	Frank Ewert	364	0,95%	6,85%
7th	Kurt-Christian Kersebaum	364	0,95%	7,80%
8th	Pierre Martre	364	0,95%	8,75%
9th	Ehsan Eyshi Rezaei	364	0,95%	9,70%
10th	Mikhail Semenov	364	0,95%	10,65%

4.1.1.5. Co-occurring Author Keywords Descriptive

The following table, Table 4.5, shows the top 20 most used keywords (author keywords and keywords plus) from a total of 1813 distinct keywords. The result shows that the most used keyword from our 433 datasets is “Strategic Foresight” with a frequency of 165, followed by “Corporate Foresight” with 145, “Innovation” 95 times, “Foresight” and “Future” 67 times, “Management” and “Technology” 49 times, “Scenarios” 40 times, “Performance” 38 times, “Futures” used 37 times and so on. Furthermore, it is possible to see that the 10 most used keywords account almost for 20% of the total keywords used in all papers from our dataset and the top 20 most used keywords account for 26,31% of the total keyword utilization.

Table 4.5 - Number of used keywords [2001-2021] (Own Source)

Rank	Keywords	Frequency [2001-2021]	% of 3861	Acc. % of 3861	Rank	Keywords	Frequency [2001-2021]	% of 3861	Acc. % of 3861
1st	Strategic Foresight	165	4,27%	4,27%	**11th**	Decision Making	34	0,88%	20,36%
2nd	Corporate Foresight	145	3,76%	8,03%	**12th**	Impact	33	0,85%	21,21%
3rd	Innovation	95	2,46%	10,49%	**13th**	Uncertainty	30	0,78%	21,99%
4th	Foresight	67	1,74%	12,22%	**14th**	Knowledge	27	0,70%	22,69%
5th	Future	67	1,74%	13,96%	**15th**	Dynamic Capabilities	26	0,67%	23,36%
6th	Management	49	1,27%	15,23%	**16th**	Strategy	25	0,65%	24,01%
7th	Technology	49	1,27%	16,50%	**17th**	Technology Foresight	23	0,60%	24,61%
8th	Scenarios	40	1,04%	17,53%	**18th**	Climate Change	22	0,57%	25,17%
9th	Performance	38	0,98%	18,52%	**19th**	Framework	22	0,57%	25,74%
10th	Futures	37	0,96%	19,48%	**20th**	Organizations	22	0,57%	26,31%

4.1.1.6. Document Co-citation Descriptive

The following table, Table 4.6, presents the most cited papers from a total of 5670 citations in the 433 papers. The paper Liu et al. (2016) was cited 198 times, followed by Rohrbeck and Gemünden (2011) with 155 citations, Durance and Godet (2010) with 124 citations, Naik et al. (2005) with 122 citations, Asseng et al. (2019) with 105 citations, Sprigmann et al. (2017) with 98 citations, Rohrbeck and Schwarz (2013) with 91 citations, Rohrbeck et al. (2015) and Vecchiato and Roveda (2010) with 90 citations each, and Habegger (2010) with 88 citations. The top 10 most cited publications account for 20,48% of the total citations.

Table 4.6 - Number of citations per Reference [2011-2021] (Own Source)

Rank	Publications	**APA** Reference	Journal	Citations [2001-2021]	% of 5670	Acc. % of 5670
1st	Similar estimates of temperature impacts on global wheat yield by three independent methods.	Liu et al. (2016)	Nature Climate Change	198	3,49%	3,49%
2nd	Corporate foresight: Its three roles in enhancing the innovation capacity of a firm.	Rohrbeck & Gemünden (2011)	Technological Forecasting and Social Change	155	2,73%	6,23%
3rd	Scenario building: Uses and abuses.	Durance & Godet (2010)	Technological Forecasting and Social Change	124	2,19%	8,41%
4th	Planning marketing-mix strategies in the presence of interaction effects.	Naik et al. (2005)	Marketing Science	122	2,15%	10,56%
5th	Climate change impact and adaptation for wheat protein.	Asseng et al. (2019)	Global Change Biology	105	1,85%	12,42%
6th	Mitigation potential and global health impacts from emissions pricing of food commodities.	Springmann et al. (2017)	Nature Climate Change	98	1,73%	14,14%
7th	The value contribution of strategic foresight: Insights from an empirical study of large European companies.	Rohrbeck & Schwarz (2013)	Technological Forecasting and Social Change	91	1,60%	15,75%
8th	Corporate foresight: An emerging field with a rich tradition.	Rohrbeck et al. (2015)	Technological Forecasting and Social Change	90	1,59%	17,34%
9th	Strategic foresight in corporate organizations: Handling the effect and response uncertainty of technology and social drivers of change.	Vecchiato & Roveda (2010)	Technological Forecasting and Social Change	90	1,59%	18,92%
10th	Strategic foresight in public policy: Reviewing the experiences of the UK, Singapore, and the Netherlands.	Habegger (2010)	Futures	88	1,55%	20,48%

4.1.2. Bibliometric Analysis

Now that we gathered descriptive insights on the current CF literature, in this section we will present the results of our bibliometric analysis for each created network, mentioned in 3.4, and the clustering results for the documents co-citation network. As mentioned, the selection criteria applied for all networks was the g-index with k=25.

4.1.2.1. Networks

In this section, we present the bibliometric results of the four generated networks.

4.1.2.1.1. Journal Co-citation Network

Figure 4.3 represents the visualization of the journal co-citation network. This network contains 589 nodes and 3432 links. It is possible to see the journals with more citations as they are represented with a bigger circle. The circle with a purple ring represents the journals with a betweenness centrality higher than 0.1, and the thicker the ring the higher the centrality (Chen, 2010). Additionally, the circles with a red ring indicate that the journal is a burst item (Chen, 2010). In Table 4.7 is possible to see the top 20 cited journals with the strongest citation burst and the occurrence of the burst, from a total of 39 automatically generated bursts using CiteSpace.

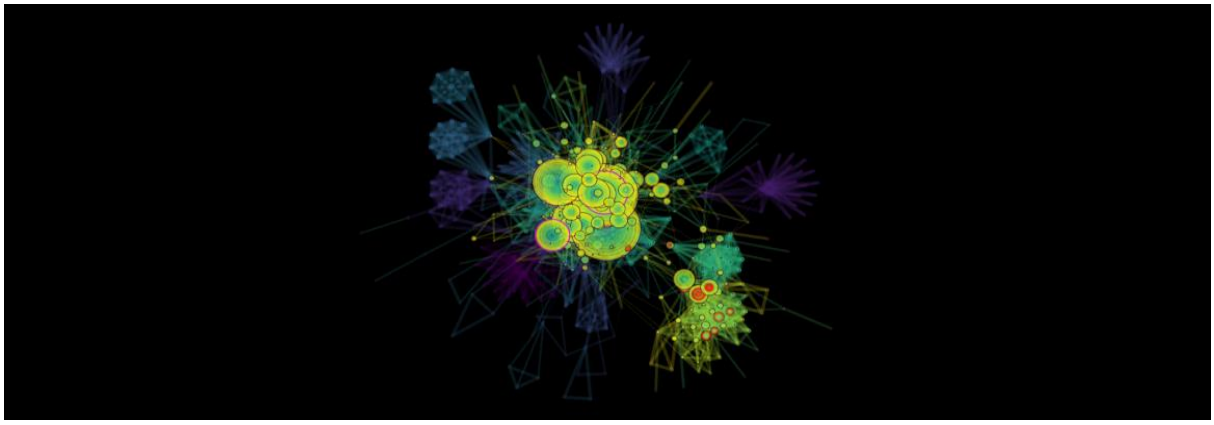

Figure 4.3 - Journal Co-citation Network (Own source)

Table 4.7 - Top 20 Cited journals with the Strongest Citation Bursts [2001-2021] (Own Source)

Top 20 Cited Journals with the Strongest Citation Bursts					
Cited Journals	Year	Strength	Begin	End	2001 - 2021
Social Psychology Network	2001	3.61	**2004**	2010	
Competing for the Future (ISBN: 9780875847160)	2001	3.18	**2004**	2011	
American Journal of Sociology	2001	3.31	**2006**	2015	
The Art of the Long View: Planning the Future in na Uncertain World (ISBN: 9780385267328)	2001	4.45	**2008**	2012	
Competitive Advantage (ISBN: 9781416595847)	2001	3.63	**2010**	2012	
Futures Research Methodology	2001	3.79	**2012**	2014	
Peripheral Vision (ISBN: 9781422101544)	2001	3.39	**2012**	2015	
Handbook of Research Methodology (ISBN: 9781545703403)	2001	3.35	**2013**	2015	
Strategic Change	2001	3.34	**2015**	2016	
PNAS	2001	3.72	**2016**	2017	
Nature Journal	2001	4.05	**2016**	2018	
Psychological Review	2001	3.17	**2016**	2018	
Global Environmental Change	2001	3.86	**2016**	2019	
Environment Research Letters	2001	4.42	**2016**	2019	
European Journal of Agronomy	2001	3.59	**2016**	2019	
Nature Climate Change	2001	3.59	**2016**	2019	
Global Change Biology	2001	3.31	**2016**	2019	
International Journal of Management Reviews	2001	3.78	**2018**	2021	
Journal of Cleaner Production	2001	5.68	**2019**	2021	
Journal of Applied Psychology	2001	3.52	**2019**	2021	

Table 4.8 represents the top 10 journals by metric (frequency, burst, degree of centrality, betweenness of centrality, and digma, respectively). We can see that the journal of Technology Forecasting and Social Change was cited 237 times.

Moreover, the journal of cleaner Production has the highest burst value, 5.68. The journal of Administrative Science Quarterly has the biggest degree of centrality (102) and the higher betweenness centrality value (0.2). Also, the book “The Art Of The Long View: Planning For The Future In An Uncertain World” has the highest sigma, 1.33.

Table 4.8 - Top 10 Journals per bibliometrics [2001-2021] (Own Source)

Rank	Freq.	Journal	Burst	Journal	Degree	Journal	Centrality	Journal	Sigma	Journal
1st	237	Technological Forecasting & Social Change	5.68	Journal of Cleaner Production	102	Administrative Science Quarterly	0.20	Administrative Science Quarterly	1.33	The Art of the Long View
2nd	215	Futures	4.45	The Art of the Long View	101	Academy of Management journal	0.17	Academy of Management journal	1.32	Global Environment Change
3rd	155	Foresight	4.42	Environmental Research Letters	74	Long Range Planning	0.11	Harvard Business Review	1.28	Futures Research methodology
4th	127	Technology Analysis and Strategic management	4.05	Nature	74	Academy of Management Review	0.09	Futures	1.11	PNAS
5th	126	Strategic Management Journal	3.86	Global Environment Change	65	Strategic Management Journal	0.09	Science	1.07	Competing for the Future
6th	116	Long Range Planning	3.79	Futures Research Methodology	65	California Management Review	0.09	The Art of Conjecture	1.05	Strategic Change
7th	114	Harvard Business Review	3.78	International Journal of Management Reviews	63	Journal of Management	0.08	Journal of Future Studies	1.04	Global Environment Change
8th	111	Academy of Management Review	3.72	PNAS	58	Organization Science	0.07	California Management Review	1.03	Journal of Cleaner Production
9th	88	Organization Science	3.63	Competitive Advantage	58	Journal of Management Studies	0.07	The Art of the Long View	1.03	Environmental Research Letters
10th	83	Administrative Science Quarterly	3.61	Social Psychology Network	55	Harvard Business Review	0.07	American Economic Review	1.03	International Journal of Management Reviews

4.1.2.1.2. Author Co-citation Network

Figure 4.4 represents the visualization of the author's co-citation network. This network contains 594 nodes and 3558 links. In Figure 4.4 it is possible to see the authors with more citations as they are represented with a bigger circle, the authors with higher betweenness centrality, and the ones that are considered burst items. Table 4.9 shows the top 20 cited authors with the strongest citation bursts and time of burst.

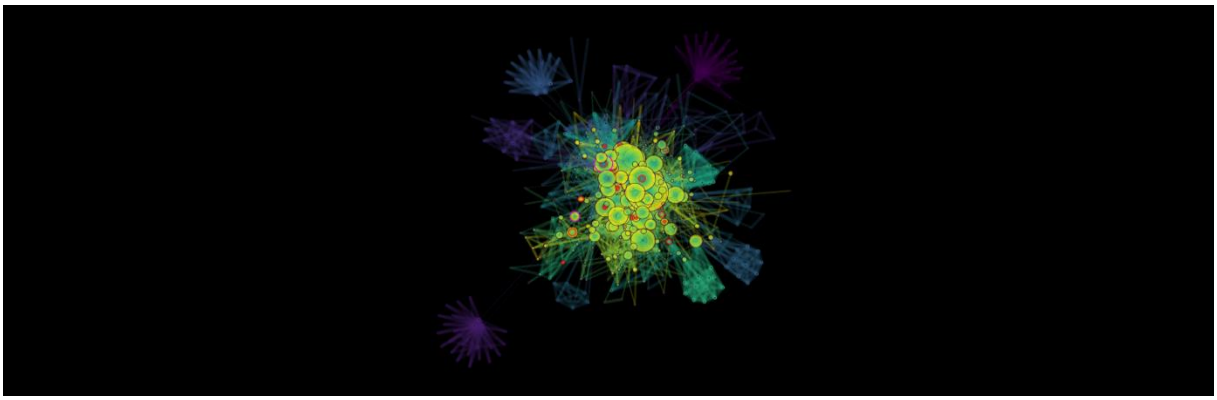

Figure 4.4 - Author Co-citation Network (Own source)

Table 4.9 - Top 20 Cited authors with the Strongest Citation Bursts [2001-2021] (Own Source)

Top 20 Cited Authors with the Strongest Citation Bursts					
Cited Authors	Year	Strength	Begin	End	2001 - 2021
Harry Igor Ansoff	2001	7.26	2006	2012	
Peter Schwartz	2001	4.27	2006	2012	
Liam Fahey	2001	3.91	2006	2015	
Alan Porter	2001	4.3	2010	2012	
Darrell Rigby	2001	3.66	2012	2015	
Tobias Gnatzy	2001	3.55	2013	2015	
Effie Amanatidou	2001	5.21	2014	2016	
Heiko von Der Gracht	2001	3.95	2014	2015	
Theodore Gordon	2001	3.82	2014	2015	
Averil Horton	2001	4.44	2016	2018	
Konstantin Vishnevskiy	2001	3.91	2016	2019	
Frank Ruff	2001	4.95	2017	2018	
Patrick van der Duin	2001	4.59	2017	2021	
Angela Wilkinson	2001	3.62	2017	2021	
Martin Rhisiart	2001	3.94	2018	2021	
Siri Boe-Lillegraven	2001	3.87	2018	2021	
Jakob Højland	2001	3.61	2018	2021	
Regina Gattringer	2001	3.61	2018	2021	
Jon Iden	2001	6.25	2019	2021	
Tugrul Daim	2001	3.7	2019	2021	

Table 4.10 shows the top 10 authors from the author co-citation network per metric. From Table 4.10 we can see that René Rorhbeck was the most cited author, 146 times, Harry Igor Ansoff has the highest degree of centrality, 79, and Michael Porter has the highest betweenness centrality value, 0,15. Harry Igor Ansoff has the highest burst value, 7,26 and he was also the highest sigma value, 2.12.

Table 4.10 - Top 10 authors per bibliometrics [2001-2021] (Own Source)

Rank	Freq.	Author	Burst	Author	Degree	Author	Centrality	Author	Sigma	Author
1st	146	René Rohrbeck	7.26	Harry Igor Ansoff	79	Harry Igor Ansoff	0.15	Michael Porter	2.12	Harry Igor Ansoff
2nd	96	Ricciardo Vecchiato	6.25	Jon Iden	63	George Burt	0.11	Harry Igor Ansoff	1.22	Effie Amanatidou
3rd	63	Cornelia Daheim	5.21	Effie Amanatidou	62	Cornelia Daheim	0.10	George Day	1.19	Michel Godet
4th	59	Kathleen Eisenhardt	4.95	Frank Ruff	57	Kathleen Eisenhardt	0.08	Gary Hamel	1.11	Heiko von der Gracht
5th	51	Frank Ruff	4.59	Patrick van der Duin	55	René Rohrbeck	0.07	Richard Daft	1.09	Rafael Ramirez
6th	50	Tobias Heger	4.44	Averil Horton	55	Thomas Chermack	0.07	Sohail Inayatullah	1.08	Frank Ruff
7th	49	Michel Godet	4.30	Alan Porter	53	Gary Hamel	0.07	David Teece	1.08	Liam Fahey
8th	48	Peter Schwartz	4.27	Peter Schwartz	53	Joseph Coates	0.06	George Burt	1.08	Alper Alsan
9th	48	Kees van der Heijden	3.95	Heiko von Der Gracht	50	Paul Schoemaker	0.06	Kathleen Eisenhardt	1.08	Alan Porter
10th	48	Andy Hines	3.94	Martin Rhisiart	48	Tobias Heger	0.06	Michel Godet	1.07	Averil Horton

4.1.2.1.3. Co-occurring Author Keywords Network

Figure 4.5 represents the visualization of the co-occurring author keywords network. This network contains 312 nodes and 1656 links. In Figure 4.5 it is possible to see the most used keywords as they are represented with a bigger circle, the keywords with higher betweenness centrality and, although more difficult, the ones that are considered burst items. Table 4.11 shows the top 5 keywords with the strongest citation burst and time of occurrence.

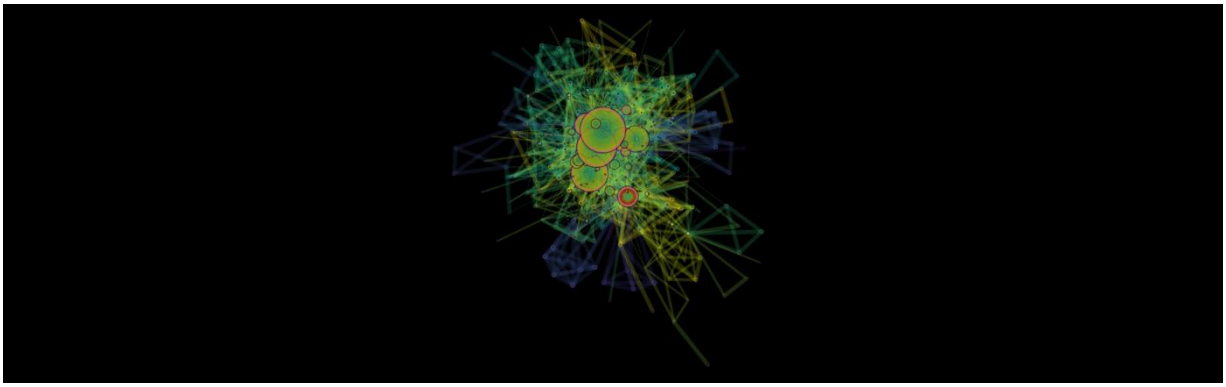

Figure 4.5 - Co-occurring Author Keywords Network (Own source)

Table 4.11 - Top 5 Keywords with the Strongest Citation Bursts [2001-2021] (Own Source)

Top 5 Keywords with the Strongest Citation Bursts					
Keywords	Year	Strength	Begin	End	2001 - 2021
Perception	2001	2.95	2006	2012	
Real Time	2001	2.68	2013	2015	
Industry	2001	2.27	2017	2018	
Open Innovation	2001	2.57	2018	2019	
Impact	2001	2.32	2019	2019	

In Table 4.12 it is possible to see the top 10 keywords by metric. The keyword “Future” was the most used keyword, 88 times, “Management” as the highest degree of centrality and betweenness centrality, 81 and 0.19, respectively, and “Perception” has the highest burst value, 2,95, and “Impact” the highest sigma value, 1,50.

Table 4.12 - Top 10 keywords per metric [2001-2021] (Own Source)

Rank	Freq.	Keyword	Burst	Keyword	Degree	Keyword	Centrality	Keyword	Sigma	Keyword
1st	88	Future	2.95	Perception	81	Management	0.19	Management	1.50	Impact
2nd	86	Corporate Foresight	2.68	Real Time	72	Innovation	0.19	Impact	1.14	Industry
3rd	67	Innovation	2.57	Open Innovation	71	Corporate Foresight	0.15	Performance	1.11	Perception
4th	56	Strategic Foresight	2.32	Impact	68	Performance	0.13	Innovation	1.02	Real Time
5th	47	Technology	2.27	Industry	65	Future	0.13	Corporate Foresight	1.00	Management
6th	43	Management	-	Future	62	Impact	0.13	Future	1.00	Performance
7th	38	Impact	-	Corporate Foresight	62	Decision Making	0.10	Decision Making	1.00	Innovation
8th	38	Performance	-	Innovation	58	Knowledge	0.10	Strategic Foresight	1.00	Corporate Foresight
9th	26	Knowledge	-	Strategic Foresight	54	Strategic Foresight	0.10	Framework	1.00	Future
10th	24	Uncertainty	-	Technology	53	Framework	0.10	Uncertainty	1.00	Decision Making

4.1.2.1.4. Document Co-citation Network

Figure 4.6 represents the visualization of the document co-citation network. This network contains 663 nodes and 2315 links. In Figure 4.6 it is possible to see the most cited references as they are represented with a bigger circle and the ones that are considered burst items. Zero references had a betweenness centrality higher than 0.1 and therefore in the network, no purple ring can be identified. Table 4.13 shows the top 20 references with the strongest citation burst.

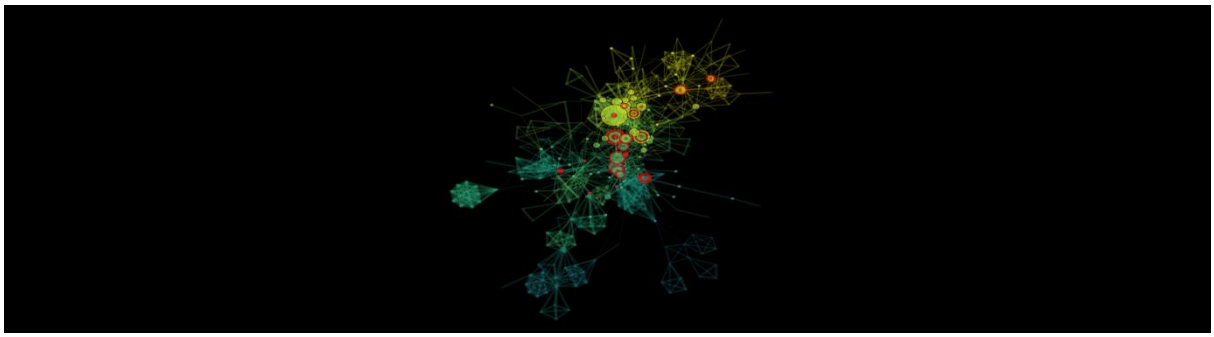

Figure 4.6 - Document Co-citation Network (Own source)

Table 4.13 - Top 20 references with the Strongest Citation Bursts [2001-2021] (Own Source)

Top 20 References with the Strongest Citation Bursts					
References	Year	Strength	Begin	End	2001 - 2021
Vecchiato & Roveda (2010)	2010	7.36	**2012**	2015	
Rohrbeck & Gemünden (2011)	2011	10.57	**2013**	2016	
von der Gracht et al. (2010)	2010	6.12	**2013**	2015	
Bootz (2010)	2010	4.06	**2013**	2015	
Rohrbeck (2012)	2012	7.42	**2014**	2017	
Heger & Rohrbeck (2012)	2012	6.79	**2014**	2017	
Vecchiato (2012)	2012	6.54	**2014**	2016	
Rohrbeck (2011)	2011	5.92	**2014**	2016	
Rohrbeck & Schwarz (2013)	2013	8.73	**2015**	2018	
Battistella (2014)	2014	4.3	**2015**	2018	
Vishnevskiy et al. (2015)	2015	3.71	**2016**	2019	
Ruff (2015)	2015	6.4	**2017**	2019	
van der Duin et al. (2014)	2014	4.83	**2017**	2019	
Rohrbeck et al. (2015)	2015	13.82	**2017**	2021	
Heger & Boman (2015)	2015	4.87	**2017**	2021	
Boe-Lillegraven & Monterde (2015)	2015	4.29	**2017**	2021	
Vecchiato (2015)	2015	3.76	**2017**	2021	
Paliokaite & Pačesa (2015)	2015	3.71	**2017**	2021	
Rohrbeck & Kum (2018)	2018	8.97	**2019**	2021	
Iden et al. (2017)	2017	6.2	**2019**	2021	

Table 4.14 shows the top 10 references per metric. From Table 4.14 we can see that the reference Rohrbeck et al. (2015) was the most cited, 47 times, Heger and Boman (2015) as the highest degree of centrality, 37, and Rohrbeck and Kum (2018) betweenness centrality, 0,07. Furthermore, Rohrbeck et al. (2015) have the highest burst value, 13,82, and Rohrbeck and Kum (2018) have the highest sigma value, 1,90.

Table 4.14 - Top 10 Reference per bibliometrics [2001-2021] (Own Source)

Rank	Freq.	APA Reference	Burst	APA Reference	Degree	APA Reference	Centrality	APA Reference	Sigma	APA Reference
1st	47	Rohrbeck et al. (2015)	13.82	Rohrbeck et al. (2015)	37	Heger & Boman (2015)	0.07	Rohrbeck & Kum (2018)	1.90	Rohrbeck & Kum (2018)
2nd	34	Rohrbeck & Schwarz (2013)	10.57	Rohrbeck & Gemünden (2011)	35	Vecchiato & Roveda (2010)	0.06	Vecchiato (2015)	1.48	Vecchiato & Roveda (2010)
3rd	34	Rohrbeck & Gemünden (2011)	8.97	Rohrbeck & Kum (2018)	31	Vecchiato (2015)	0.06	Georghiou et al. (2009)	1.29	Rohrbeck et al. (2015)
4th	24	Rohrbeck (2012)	8.73	Rohrbeck (2012)	31	Andersen & Andersen (2014)	0.06	Habegger (2010)	1.28	Rohrbeck & Gemünden (2011)
5th	22	Heger & Rohrbeck (2012)	7.42	Vecchiato & Roveda (2010)	30	Rohrbeck & Kum (2018)	0.05	Vecchiato & Roveda (2010)	1.25	Heger & Rohrbeck (2012)
6th	21	Ruff (2015)	7.36	Rohrbeck (2011)	30	Battistella & De Toni (2011)	0.05	Andersen & Andersen (2014)	1.24	Vecchiato (2015)
7th	21	Vishnevskiy et al. (2015)	6.79	Heger & Rohrbeck (2012)	27	Rohrbeck (2011)	0.05	Battistella & De Toni (2011)	1.24	Vecchiato (2010)
8th	20	Rohrbeck & Kum (2018)	6.54	Vecchiato (2010)	27	van der Duin et al. (2014)	0.05	Daheim & Uerz (2008)	1.22	Heger & Boman (2015)
9th	20	Vecchiato & Roveda (2010)	6.4	Ruff (2015)	26	Paliokaite & Pačesa (2015)	0.04	Heger & Boman (2015)	1.21	Vecchiato & Roveda (2010)
10th	19	Rohrbeck (2011)	6.2	Iden et al. (2017)	25	Heger & Rohrbeck (2012)	0.04	Amanatidou et al. (2012)	1.18	Battistella & De Toni (2011)

4.1.2.2. Document Co-Citation Clustering Analysis

CiteSpace grouped the references into 82 clusters, which resulted in a mean modularity Q of 0.8214 and a mean silhouette value of 0.9157. CiteSpace only displays the largest connected component of the network, by default, as a result, clusters that are not on the biggest linked component will be invisible (CiteSpace.Podia, 2021). Therefore, from the 82 clusters, CiteSpace only displays 9 clusters. In the following table, Table 4.15, it is possible to see the 9 clusters information and in Figure 4.7 the timeline view of the clusters, the respective interconnections between the references of each cluster, and the burst references (red ring).

Table 4.15 - Document Co-citation Clustering Information (Own Source)

Cluster ID	Cluster name LLR	Size	Silhouette	From - To
0	Open Foresight	72	0.905	2012-2020
1	Rich Tradition	64	0.861	2007-2015
2	Research Opportunities	61	0.934	2014-2020
3	Accelerating Technological Change	36	0.852	2010-2016
4	Way finding	31	0.938	2008-2015
7	Proposal	28	0.957	2010-2015
8	Assessing Delphi Panel Composition	28	0.968	2005-2011
12	Portfolio-Approach	15	0.988	2005-2009
13	Conservation Opportunity	13	0.999	2009-2014

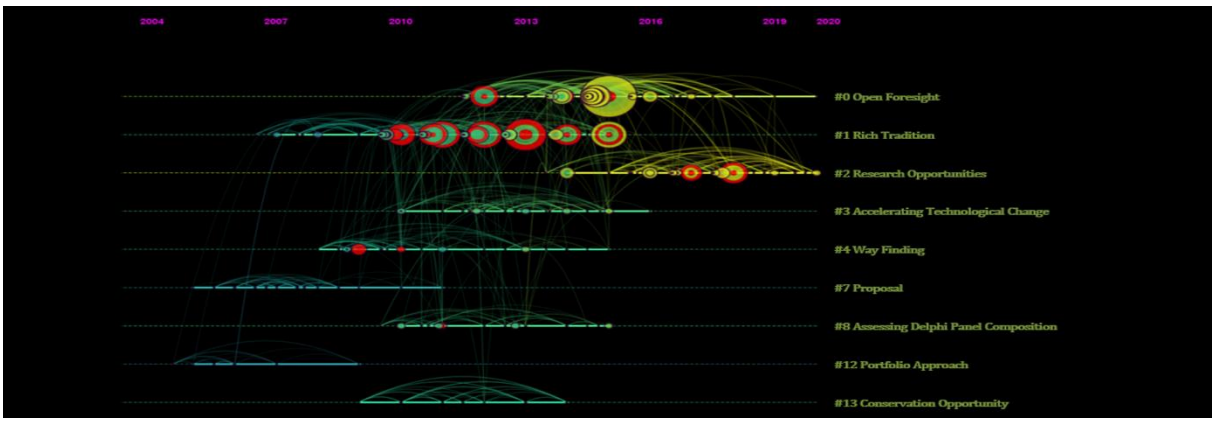

Figure 4.7 - Clusters Timeline View (Own Source)

To answer our research problem, we created a table (see Appendix B) with all the references with a burst value greater than zero, arranged by cluster, but we focused our attention on the references that have a burst period covering 2021, as those might indicate the current trends, hot topics, regarding corporate foresight (see Table 4.16) and, to have a better understanding of the references' characteristics, we also obtained the results of centrality and newness associated to the selected references.

As shown in Table 4.16, the references with a burst period covering 2021 belong to one of two clusters: cluster 0 (named "Open Foresight") and cluster 2 (named "Research Opportunities"). The name of the cluster is given by the LLR (log-likelihood ratio) algorithm.

Table 4.16 - Cluster Recent Burst Composition (Own Source)

CLUSTER	ARTICLE			MEASURES						
	Citation Count	APA Reference	Keywords	Burst Value	Burst Begin	Burst End	2001-2021	Degree of Centrality	Betweenness Centrality	Sigma of Newness
Cluster 0 (Open Foresight) **Cluster Size (Reference):** 72 **Cluster Silhouette:** 0,905	47	Rohrbeck et al. (2015)	Corporate Foresight, Strategic Foresight, Review, Historical Development	13,82	2017	2021		18,0	0,02	1,29
	17	Heger & Boman (2015)	Strategic Foresight, Business Field Exploration, Innovation Management, Open Innovation	4,87	2017	2021		37,0	0,04	1,22
	15	Boe-Lillegraven & Monterde (2015)	Corporate Foresight, Future Research, Strategic Planning, Innovation Management, Business Environment, Automotive Business	4,29	2017	2021		20,0	0,01	1,03
	18	Vecchiato (2015)	Corporate Foresight, Networked Foresight, Innovation Networks, Collaboration for Innovation, Open Innovation, Dynamic Capabilities	3,76	2017	2021		31,0	0,06	1,24
	13	Paliokaite & Pačesa (2015)	Organisational foresight; Capabilities; Exploration; Exploitation; Organisational Ambidexterity	3,71	2017	2021		19,0	0,02	1,07
	10	Rhisiart et al. (2015)	Scenarios; Strategic Foresight; Learning	3,62	2018	2021		5,0	0,00	1,00
Cluster 2 (Research Opportunities) **Cluster Size (Reference):** 61 **Cluster Silhouette:** 0,934	20	Rohrbeck & Kum (2018)	Corporate Foresight; Future Preparedness; Firm Performance; Behavioural Theory of the Firm	8,97	2019	2021		30,0	0,07	1,90
	17	Iden et al. (2017)	Strategic Foresight; Systematic Literature Review; Corporate Foresight; Technology Foresight	6,20	2019	2021		19,0	0,01	1,06
	10	Højland & Rohrbeck (2018)	Corporate Foresight; Business Development; Cognitive Search; Experimental Search	3,62	2018	2021		12,0	0,01	1,05
	9	Gershman et al. (2016)	State-Owned Enterprises; Corporate Foresight; Technology Roadmaps; Innovation Strategies; Innovation Management	3,26	2018	2021		14,0	0,01	1,04

In *cluster 0*, there are 6 references with a burst period covering 2021 [Rohrbeck et al. (2015), Heger and Boman (2015), Boe-Lillegraven and Monteverde (2015), Vecchiato (2015), Paliokaite and Pačesa (2015), and Rhisiart et al. (2015)].

- Rohrbeck et al. (2015) were cited 47 times between 2001 and 2021, having a burst period between 2017 and 2021 with a burst value of 13,82. This reference has a degree

of centrality of 18, betweenness centrality of 0,02, and a sigma of the newness of 1,29.

- Heger & Boman (2015) were cited 17 times between 2001 and 2021, having a burst period between 2017 and 2021 with a burst value of 4,87. This reference has a degree of centrality of 37, betweenness centrality of 0,04, and a sigma of the newness of 1,22.
- Boe-Lillegraven & Monteverde (2015) were cited 15 times between 2001 and 2021, having a burst period between 2017 and 2021 with a burst value of 4,29. This reference has a degree of centrality of 20, betweenness centrality of 0,01, and a sigma of the newness of 1,03.
- Vecchiato (2015) was cited 18 times between 2001 and 2021, having a burst period between 2017 and 2021 with a burst value of 3,76. This reference has a degree of centrality of 31, betweenness centrality of 0,06, and a sigma of the newness of 1,24.
- Paliokaite & Pačesa (2015) were cited 13 times between 2001 and 2021, having a burst period between 2017 and 2021 with a burst value of 3,71. This reference has a degree of centrality of 19, betweenness centrality of 0,02, and a sigma of the newness of 1,07.
- Rhisiart et al. (2015) were cited 10 times between 2001 and 2021, having a burst period between 2017 and 2021 with a burst value of 3,62. This reference has a degree of centrality of 5, betweenness centrality of 0,00, and a sigma of the newness of 1,00.

In *cluster 2*, there are 4 references with a burst period covering 2021 [Rohrbeck and Kum (2018), Iden et al. (2017), Højland and Rohrbeck (2018) and Gershman et al. (2016)].

- Rohrbeck & Kum (2018) were cited 20 times between 2001 and 2021, having a burst period between 2017 and 2021 with a burst value of 8,97. This reference has a degree of centrality of 30, betweenness centrality of 0,07, and a sigma of the newness of 1,90.
- Iden et al. (2017) were cited 17 times between 2001 and 2021, having a burst period between 2017 and 2021 with a burst value of 6,20. This reference has a degree of centrality of 19, betweenness centrality of 0,01, and a sigma of the newness of 1,06.
- Højland & Rohrbeck (2018) were cited 10 times between 2001 and 2021, having a burst period between 2017 and 2021 with a burst value of 3,62. This reference has a degree of centrality of 12, betweenness centrality of 0,01, and a sigma of the newness of 1,05.
- Gershman et al. (2016) were cited 9 times between 2001 and 2021, having a burst period between 2017 and 2021 with a burst value of 3,26. This reference has a degree of centrality of 14, betweenness centrality of 0,01, and a sigma of the newness of 1,04.

4.2. Discussion

In this section, we will discuss the results obtained in section 4.1 that allowed us to answer our research questions.

RQ.1 sought to acknowledge the evolution of CF research in the last two decades. To answer this question, we conducted two descriptive analyses concerning publication frequency and citation frequency over 2001-2021. Our results regarding publication frequency and citation frequency showed that there is visual parallelism between the two evolution lines (see Figure 4.1 and Figure 4.2) from 2001 to 2017. We noticed that more than 85% of the total publications and more than 70% of the citations occurred after 2010, both reaching a peak in 2015, which means that interest in CF was higher after 2010. This might be related to the fact that in 2010 the world was still facing the effects of 2008 economic crisis periods of uncertainty. Furthermore, according to Bereznoy (2017), CF is a key instrument to battle uncertainty. This is also in line with Kononiuk and Sacio-Szymańska (2015) which stated that CF has emerged as an important contributor in the face of accelerating change, high business environment unpredictability, and an unprecedented volume of information. Furthermore, we saw that, after 2017, both evolution lines (publication frequency and citation frequency) diverged until 2021: the publication frequency increased, might suggest that there was a rising interest in CF in that period, and the citation frequency declined, might suggest that the most cited articles are not the most recent publications. Overall, the increased number of publications and citations, over the past few decades, suggests that CF is evolving from a new knowledge frontier to a well-established one and this is in line with Amini et al. (2021) findings.

RQ.2 sought to acknowledge the intellectual structure of CF. To answer this question, we conducted four descriptive analyses, on the journals, authors, keywords, and documents.

- The results showed that the 433 studies were published in 191 journals, which demonstrates some diversity and interest, and that, 50,5% of those studies were published only in 10 journals, which suggests that those 10 journals are more interested in publishing corporate foresight literature (see Table 4.1). Moreover, the first two journals that published more articles related to CF, Technology forecasting and Social Change and Futures Journal are also the two journals that received more citations, probably because the name of the journals is associated with the relationship between CF and uncertainty motivated by the social and economic development due to the rapid technological changes and the fast-moving diffusion of innovation (Latzer, 2009) and also because CF is seen as a future-oriented strategy (Vecchiato, 2015). Furthermore, 4

of the top 10 most cited journals are natural sciences journals: “Nature Climate Change”, “Global Change Biology”, “Conservation Letters” and “Global Food Security-Agriculture Policy Economics and Environment” (see Table 4.2). This might suggest an increasing interest in foresight studies by natural sciences practitioners. Additionally, finding general management journals in this top 10 most cited journals, such as “Technology Analysis & Strategic Management” and “Technology Innovation Management Review” and “Marketing Science” and “R&D Management”, might also suggest an increasing interest by the general strategic management school in CF.

- Looking into the authors’ descriptive analysis, we can see that more than 41% of the 433 publications (181 publications) were developed by 32 authors, which indicates that those authors are strongly interested in the proliferation of the CF approach. Authors such as René Rohrbeck, Dirk Meissner, Konstantin Vishnevskiy, Ricciardo Vecchiato, David Sarpong, and Melanie Wiener, among others, focus their efforts on research related to corporate foresight, strategic foresight, futures, scenarios, and open foresight and its impacts on management, innovation, and technology. Moreover, authors such as David Mason-d’croz, Senthold Asseng, among others focus efforts on future perspectives and scenarios research linked to agricultural and climate issues. Therefore, it might suggest, once again, the increased interest in foresight studies by the natural science area. The same applies to the most cited authors, were besides René Rohrbeck, all the authors have publications concerning climate change because most of them worked together in those publications.
- Regarding the keywords’ descriptive analysis, we can see that from the 1813 distinct references used in all 433 documents, the top 40 keywords were used 33% of the time. As expected, the two most used keywords are “strategic foresight” and “corporate foresight”. Moreover, when looking into the remaining keywords, we can see the connection between CF to innovation, technology, scenarios, performance, impact, decision making, uncertainty, among others. We also see the link with climate change which, once again, might suggest the increasing interest by the natural sciences.
- Lastly, concerning the documents’ descriptive analysis we saw that 5 of the most cited papers were published in the journal with the highest number of publications and citations, “Technological Forecasting and Social Change”, which, once again, suggests the importance of this journal in the proliferation of CF knowledge. Correspondingly it is possible to draw parallels with innovation, scenarios, uncertainty, and technology (Rohrbeck & Gemunden, 2011; Durance & Godet, 2010; Rohrbeck & Schwarz, 2013;

and Vecchiato & Roveda, 2010). Also, most of the researchers of the top 10 most cited documents are in the top 10 most productive and most cited authors, such as René Rohrbeck, Riccardo Vecchiato, Senthold Asseng, and Frank Ewert. Moreover, similarities to the previous descriptives analyses can be drawn, because three of the ten most cited articles are related to climate change issues (Liu et al., 2016; Sprigmann et al., 2017; and Asseng et al., 2019).

RQ.3 sought to acknowledge the current research trends in CF literature. To answer this question, we conducted four bibliometric analyses on journals, authors, keywords, and documents, and one clustering analysis on documents.

- By conducting the journals' bibliometric analysis, we revealed the most relevant journals in CF literature. Here applying the g-index with k=25, increased the number of studied journals. The network is, therefore, made of 589 nodes and 3432 links or connections between the nodes. The bibliometrics results show that the journals with the highest number of relationships, measured by the degree of centrality, and the ones that are closest to a center path between other nodes, measured by betweenness centrality are journals related to administrative and management science, namely "Administrative Science Quarterly", "Academy of Management Journal", "Academy of Management Review" and "Harvard Business Review". This might suggest the need for CF practitioners to justify the value of CF in comparison to the "planning school" (Bereznoy, 2017; Battistella & De Toni, 2011). Also, by studying the burstness we saw that the two of the highest burst values belong to journals related to environmental issues, the "Journal of Cleaner Production" and the "Environment Research Letters". Looking into Table 4.7 we saw that the "Journal of Cleaner Production" is a burst item, with a value of 5.68, that covers 2021, which might suggest the interest of applying foresight to production best practices to reduce environmental impacts and thus the parallelism to the descriptive analyses results. We also noticed that the "International Journal of Management Reviews" and the "Journal of Applied Psychology" are recent burst items, which might suggest the increasing interest of the general management and psychology fields in foresight. This can be explained by the relationship of CF to higher levels of innovations and performance (Rohrbeck & Kum, 2012) and its link to the role, behavior, and mental models of stakeholders (internal and external) in the path for value creation (Rohrbeck, 2012). This goes along with what Rohrbeck et al. (2015) stated in their research, that there is some isolation of CF from general management journals and these two journals might be good solutions to break path dependency from the journals

that publish the most and the most frequently cited journals. The higher burst value and recent burst period might suggest that the "Journal of Cleaner Product", "International Journal of Management Reviews", and "Journal of Applied Psychology" might be good journals to publish CF papers currently because they can bring more citations for a paper.

- Conducting the authors' bibliometric network exposed predominant authors in CF literature. When we applied the g-index with k =25, the number of authors studied decreased from 1043 authors to 594. Similarly, to the journal centrality metrics, in both degree and betweenness, we saw that the top author is an author related to the "planning school", Harry Igor Ansoff, and, again, it might suggest the use of his work to justify the need for CF in the managerial world (Bereznoy, 2017; Battistella & De Toni, 2011). The same applies to the burst value and sigma, metrics, where the top author is Harry Igor Ansoff. This follows what is specified in the managerial world, that Ansoff is the prominent reference in strategic management (Martinet, 2010). The burst occurred between 2006-2012 which might relate to the spike of CF literature in 2010. CF is a new managerial subject that disrupted what Michael Porter and Igor Ansoff believe regarding strategic management (Bereznoy, 2017) and this might suggest the appearance of Ansoff in all the metrics. Furthermore, the bibliometrics shows that Jon Iden has a burst value of 7.26 and it is a burst value that covers 2021 (see Table 4.9), which might suggest that some interest has been given to Jon Iden work, for example, the systematic literature review on the nature of strategic foresight (Iden et al, 2017), because the number of citations is increasing since 2019. Emphasis must be given to the work produced by, for example, Angela Wilkinson, Martin Rhisiart, Ski Boe-Lillegraven, Jakob Hojland, and Regina Gattringer (see more authors with recent bursts in Table 4.9) on foresight applied to job scarcity, scenario processes, cognitive value, market exploration, and collaborative foresight. Harry Igor Ansoff is the only author with a sigma value (2.12) higher than 1.5 which is directly correlated to the influence of the author in the managerial world.
- Conducting the keywords bibliometric network allowed us to understand research interest. Here applying the g-index reduces the number of studied keywords (author keywords and keywords plus), from 1813 to 312 keywords. From our results, we see that the keyword "management", has the highest centrality values. This might suggest that CF is a management approach that disrupts the general strategic management ("planning school") and it is a tool to fight the increasing difficulties in technology

planning and innovation management as it induces companies to pursue novel innovation management mechanisms (Milshina & Visghnevskiy, 2018) as well reassess the nature and processes of strategic decision making (Schweitzer et al., 2019). From the results, we also saw the relationship of CF with "innovation", "impact", and "performance". This might be explained because CF is an approach that can increase future innovations and that impacts positively R&D procedures and that increases the firm performance, by anticipating environmental changes and, thus, increases value creation (Yoon et al. 2018; Hines & Gold, 2015; Rohrbeck, 2012; Rohrbeck & Gemünden, 2011; von der Gracht et al., 2010; Adegbile et al., 2017). When looking into the burst values we see that the most recent burst keywords are "impact" and "open innovation". The relationship of "open innovation" and CF is based on the discussion of future strategies by involving and collaborating with internal and external stakeholders (Daheim & Uerz, 2008). Moreover "impact" was the only keyword with a sigma higher equal or higher than 1.5 (exactly 1.5) which is in accordance with what Rohrbeck & Kum (2018) evidenced: that future prepared companies increase the likelihood of outperforming their peers, as much as 33% higher profitability and 200% market capitalization.

- Conducting a document co-citation bibliometric analysis revealed the most important papers. In this analysis applying the g-index k=25, increased the number of studied publications, from 433 to 663. Regarding the degree of centrality, the paper with more relationships with other nodes is "Networked Foresight – The Case of EIT ICT Labs" which studies the value of networked foresight (NF) and differentiates the benefits of NF for SMEs and MNCs (Heger & Boman, 2015). When looking into the betweenness centrality we saw that the paper with the highest betweenness centrality is "Corporate Foresight and its Impact on Firm Performance: A Longitudinal Analysis", which talks about future preparedness and presents a model that analyses future preparedness by measuring the need for CF (Rohrbeck & Kum, 2018). Concerning burtness, we saw that the top document that had the higher burst value (13,82) is "Corporate Foresight: An Emerging Field with a Rich Tradition" and received more citations in the period between 2001-2021. Regarding sigma, we saw that Rohrbeck and Kum (2018) paper "Corporate Foresight and its Impact on Firm Performance: A Longitudinal Analysis" has the highest value and this might suggest a higher level of novelty compared to the remaining articles.

After that, to see connections between references, and thus highlight common topics

among them, we performed a clustering analysis to the document co-citation network. From the cluster analysis, two clusters were identified as current topics, “cluster #0” and “cluster #2”.

Cluster #0, labeled as “Open Foresight”, is the largest cluster with 72 references and has drawn interest from 2012 to 2020. The title “Open Foresight” refers to the most recent phase of corporate foresight which as mentioned by Daheim and Uertz (2008), Kononiuk et al. (2017), Wiener (2018), and Wiener and Boen (2019), and others. We focused our attention on the references that are considered burst items that cover 2021. If we investigate Appendix A, it is possible to see that from the 9 burst references, in the cluster, 6 of them cover 2021 (see also Table 4.16). The 6 references are:

- *Rohrbeck et al. (2015)* - This article, “Corporate foresight: An Emerging field with a rich tradition” summarizes CF knowledge and clarifies terminologies, from 1950 to 2015, and here lays the value of the article for the scientific community. Although it is difficult to see the relationship between the article and the name of the cluster, when looking into the content of the article, we see the reason for being placed in this cluster. The authors, Rohrbeck et al. (2015), considered CF in networked organizations an emerging issue. Thus, the link between this article and the cluster since there is a connection between network organizations, collaborative exploration, and openness.
- *Heger & Boman (2015)* - This article, “Networked foresight – The case of EIT ICT Labs” explores the value of networked foresight based on a case study and survey. The research shows that networked foresight creates value for companies and value is even higher for SMEs because MNCs focus more on their established foresight procedures. Moreover, the researchers concluded that network partners predominantly see value creation from sensing activities. The authors suggest that further research should be done regarding the value proposition and the differences between MNCs and SMEs. The link between the article and the cluster is the aim to provide an understanding of the value creation of foresight in networks.
- *Boe-Lillegraven & Monterde (2015)* - This article “Exploring the cognitive value of technology foresight: The case of Cisco Technology Radar” investigates how and why foresight impact information processing methods, first conceptually and then in practice using the Cisco Technology Radar as an example. The article's authors concluded that a fundamental mechanism of a system like the radar is its probing of analytical thinking, as well as its means of connecting and exchanging

perspectives across functions and departments. These findings have implications for future studies into the processes through which foresight delivers value, as well as for the practice of planning, executing, and encouraging involvement in technological foresight.

- *Vecchiato (2015)* - This article "Creating value through foresight: First mover advantages and strategic agility" investigates the value that organizations produce via foresight when confronted with increasing uncertainty due to the rapid speed of external changes and explores how CF activities enhance strategic agility. The analysis is based on three main research streams: environmental uncertainty, strategic planning, and organizational learning, and organizational memory. This article acknowledges the need for a framework that is aware of the true value of CF and thereby the financial advantage that can be gained by incorporating CF in firms' operations. Furthermore, it also highlights the need to study first-mover advantages strategies made by decision-makers and the conditions such views may be successful.
- *Paliokaite & Pačesa (2015)* – This article "The relationship between organizational foresight and organizational ambidexterity" focuses on the positive relationship between organizational foresight and organizational ambidexterity (radical and incremental innovations). The authors' research shows that environmental scanning, integrative and strategic selection capabilities foster radical innovations, and mainly integrating capabilities foster incremental innovations. Therefore, results suggest that regular environmental scanning, visioning (road mapping and scorecard), R&D capacity and continuous organizational learning, strong leadership capabilities, building future scenarios to acquire new information are key subjects for firms to invest in to increase their explorative innovation outcomes. While paying attention (visioning) to the strategic options, good coordination and strong relationships with stakeholders increase their exploitative innovation outcomes. The authors suggest further examination of the causal links between foresight and ambidexterity considering different sectors, mature or immature economies, and the cycle of innovation development.
- *Rhisiart et al. (2015)* – This article "Learning to use the future: developing foresight capabilities through scenario processes" investigates to what extent managers and strategists learn from participation within strategic scenario processes. It is built based on an evaluative framework to document the effects of using foresight to

increase knowledge. By investing in scenarios companies are increasing the capability of strategists to sense change increasing organizational learning. The article mentions that the learning value for individuals is domain-based (exploration and understanding of a given subject) and capacity building (know how to use the future). This enables collective mental models changes within the organization and enhances the sensing dynamic capabilities throughout the organization enhancing the reflection on the differences between predictive and probabilistic assumptions routinely inherent to strategists. The authors mention the need for robust scenario theory.

By looking into the current burst articles, in cluster #0, it is harder to draw a link to OF compared to CF. Nevertheless, these references might suggest that the topic of "Open Foresight" is active, since these articles can be used to justify open foresight studies. For example, it is possible to draw a parallelism between network foresight, strategic agility, strong relationships with stakeholders and their involvement in the innovation process, and dynamic capabilities to open foresight. All these factors are are inherent to the openness and collaboration to and with other companies as studied by Daheim and Uerz (2008), von der Gracht et al. (2010), Ehls et al. (2017), Kononiuk et al. (2017), Wiener (2018), Wiener and Boer (2019) and Wiener (2020).

Regarding cluster #2, labeled as "Research Opportunities", although, it is composed of 61 references, we focused our attention on the references that are considered a burst item that covers 2021. By looking into, Appendix X, it is possible to see all 4 references are considered burst items.

- *Rohrbeck & Kum (2018)* – This article "Corporate foresight and its impact on firm performance: A Longitudinal analysis" suggests a model for evaluating a firm´s future preparedness by comparing the maturity of firm´s CF practices and assessing the need for CF and thus validating that CF helps firms, the vigilant ones, to break path dependencies and attaining higher performance and profitability. Furthermore, the research revealed that future prepared companies had 33% higher profitability and 200% higher market capitalization, and those that are not future prepared a profitability discount ranging from 37% to 44 % and loss of market capitalization ranging from 49% to 108%. The authors suggest that further research should be done in a multi-modal approach and qualitative analysis.
- *Iden et al. (2017)* – This article "The nature of strategic foresight research: A systematic literature review" concluded that there is an increasing academic

interest, but the strategic foresight field is disorganized and there is a lack of theoretical progress. The authors determined that three areas of study stand out: methodologies used, organizational practices, and lessons learned. Furthermore, the authors realized that exploratory research dominates the field and suggest that further explanatory research be developed because it can also contribute to firms' success.

- *Højland & Rohrbeck (2018)* – This paper, "The role of corporate foresight in exploring new markets – evidence from 3 case studies in the BOP markets" examines how effective company development actions in uncertain situations may be characterized as (CF) and how planned and systematic they have been. Their findings suggest that systematic CF methodologies are sporadically being used in the early stages, increasing the chance for opportunities to be undetected and therefore unexplored and unexploited. On contrary the successful cases are inherent to numerous cycles of perceiving, prospecting, and probing activities, implying that effective business growth, based on CF, is a non-linear process that relies on feedback loops and takes time.
- *Gershman et al. (2016)* – This research "The role of corporate foresight and technology roadmapping in companies' innovation development: The case of Russian state-owned enterprises" explores the role of CF and technology road mapping in innovation strategies of Russian state-owned companies. Their finding suggests that in state-owned enterprises there is a lack of long-term technology planning due to higher concerns in modernization, focus on internal markets, commitment to public procurement, and the management structure.

By looking into the current burst articles, in cluster #2, it is possible to draw the link between the articles and the cluster label "Research Opportunities" since three of the four current burst articles, Rohrbeck and Kum (2018), Højland and Rohrbeck (2018) and Gershman et al. (2016) are case studies, exploratory research.

Furthermore, the remaining article affiliation to the cluster, Iden et al. (2017), suggests that corporate foresight needs explanatory research, besides the exploratory ones, to find answers to problems that were not studied in-depth.

4.2.1. Study Implications

In contrary to the most common ways of literature research, such as state-of-the-art or systematic literature reviews, this study's bibliometric analysis diminishes the subjective judgments related to a qualitative analysis by increasing the quantitative and computational approaches to analyze past research and seek paths for future research. The descriptive analysis suggests that there is a tendency for the increase of future research on corporate foresight and the bibliometric analysis proposes in what journals researchers should publish their papers to get more citations, what authors to cite, keywords to use, and references to explore. This allows managers, researchers, and practitioners to gain in-depth knowledge of CF literature.

Theoretically, our findings support past research, especially the ones that talk about open foresight as the future research stream of CF and, support the ones that show the opportunities and gains of companies' from applying CF practices, based on the label and current burst components of the two clusters analyzed.

In the practical sense, our findings suggest that there is room for researchers to study open foresight and CF opportunities because they are still subject areas of interest since they are active clusters. Thus, there is room for management practitioners to adopt CF as a way to tackle market uncertainty due to technological innovations' quick pace of change, to open their cognition based on others' knowledge, and to seek market opportunities preemptively. Moreover, our findings show that explanatory research should be considered besides exploratory research. This will allow us to expand CF into companies' current operations because in explanatory research we are dealing with in-depth problems.

5. Conclusion, Limitations, and Paths for Future Research

In this chapter, we start by presenting the conclusions of our study and then we identify some study limitations and paths for future research.

5.1. Conclusions

As the business environment becomes more uncertain, the need for new managerial theories emerged to disrupt the general strategic management approach. Corporate foresight arose as a future-oriented uncertainty management approach that allows companies to achieve future preparedness, competitive advantages, and peak performance during and after periods of discontinuous change. This is possible by proactively anticipating and monitoring expected impacts, by gathering internal and external insights, by igniting innovation, by breaking path dependencies regarding managerial mental models and, by increasing market cognition. According to the literature, the future of CF was the openness to other firms to utilize their knowledge collaboratively. Our research showed that we are already in this stage of CF as it is a current subject.

To our knowledge, this study was the first to explore CF research, journals, authors, keywords, and documents with bibliometric analysis. The present research is based on the analysis of 433 studies published between 2001-2021 to computationally find current trends and better understand the evolution of the field. For that reason, we used CiteSpace as the main tool to get and discuss our results.

Our results suggest that CF research has attracted some attention in the past two decades since the publication frequency has increased. This fact is also confirmed when investigating the journals, authors, keywords, and references. Journals, such as the Journal of Cleaner Production, Environmental Letters, and Global Environment Change among others, from the general strategic management, and natural sciences, have started publishing foresight literature and this can be seen in both journal descriptive and bibliometric analysis. The obtained results also show the influence of René Rohrbeck, Cinzia Battistella, Eeljo Huizingh, Tobias Heger, Magnus Boman, Menes Etingue Kum, Ricciardo Vecchiato, and Hans Gemünden, among others, with their pivotal articles in CF literature and proliferation. The results also validate the close relationship between CF and innovation and open innovation, industry, impact, performance, decision-making, and uncertainty. Finally, the results showed two active clusters “Open Foresight” and “Research Opportunities”. The clustering analysis allowed us to understand that, currently, we are in the open foresight stage, as predicted by some authors.

Moreover, the research showed that there is room for investigation of open foresight and exhibited that explanatory research should be performed.

When combining both keyword bibliometric analysis (burst and sigma values) and clustering analysis, we can extrapolate the need for a continuous study of open foresight and its impact on firm performance, as well as the application of open foresight in one specific industry and the consideration of both stakeholders, internal and external, perceptions of this managerial approach. Furthermore, the results suggest that future studies should follow an explanatory approach. The combination of all the results also suggests that efforts should be given to study climate change issues while applying open foresight as a mitigation approach. A good journal to publish a paper like this would be the Journal of Cleaner Production since it is a current burst journal.

Moreover, this study allowed us to acknowledge the potential of CF in both educational and partitional ways. We understand the relevance of this approach for companies as a disruptive approach to the general strategic management methodology. However, we consider that efforts should be implemented to structuralize CF and all the subgenre topics, such as strategical foresight, organizational foresight, technological foresight, networked foresight, collaborative foresight, and open foresight. This will allow a better cognition of the field and its proliferation outside the academic field.

5.2. Limitations

In our view, the big limitation of a bibliometric analysis is that the quantitative results are purely based on automated statistical analysis produced by CiteSpace. However, it does combine quantitative and qualitative analysis. Another limitation is the sample size. CF is not a mainstream management strategy approach and thus compared to "planning school" the data to be analyzed is smaller because there are simply fewer papers published, which might have limited our conclusions. Another limitation is that the data amount is directly correlated with the search query introduced in either available research engine, Web of Science, or other, as it might have been too much restrictive, culminating in the eventual loss of information that could be interesting to be studied.

Moreover, when we defined our query, we decided to run it by all fields in WoS to gather the maximum data possible, especially in a subject that only shows 433 studies. This might have polluted the extracted initial data, because WoS gathers information from documents acknowledgments and other sources and sometimes it cross-references with studies that do not

investigate the query fields, in our case corporate, strategical, and organizational foresight.

Furthermore, analyzing research trends and future research paths based on journals, authors, keywords, and references might be contentious because findings and future paths will be more biased towards what is currently being worked on. Therefore, it is possible to advise for future research in open foresight or opportunities, but it is harder to advise for future main research topics within CF.

Furthermore, to select the articles that were summarized in this study, we started by clustering references and letting an algorithm labeling the cluster based on the most occurrent words from the most cited papers might not produce the most accurate result, such as, in the case of cluster #2 labeled “Research Opportunities”.

Also, we chose to focus our attention on the clusters with references with burst periods covering the year 2021, because we wanted to get a deeper understanding of current trends, which means that important references might not have been noticed in this research. The same applies when considering which paper is potentially revolutionary scientific or has innovative ideas behind based on a statistic value, betweenness centrality, and sigma value, respectively.

5.3. Paths for Future Research

Our study opened doors for future research since it identifies some trends regarding corporate foresight, and it summarizes a considerable number of studies into descriptive numbers. Thus, in this section, we identify some possibilities for future research, both in terms of methodology and in terms of corporate foresight trends.

Regarding the methodology, one possibility for the future is to replicate this same study but using a different query and then compare results, to strengthen the conclusions we reached. Another path for future research is to use different selection criteria methods, g-index with different k factor or performing the top N, to see if the results change. Moreover, future research can use different labeling procedures, LSI, and MI, when performing clustering analyses.

To increase the understanding of corporate foresight topics and to contribute to corporate foresight development and implementation in a wide range of corporations around the globe, we suggest exploring more in-depth the trends that we identified in this study, namely open foresight, explanatory research opportunities, perception of foresight players (internal and external) and the application of open foresight to specific industries and climate issues.

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Appendices

Appendix A - WoS Full Records Export Data Columns (Own source)

Full Records				
Authors	Book Authors	Book Editors	Book Group Authors	Author Full Names
Group Authors	Article Title	Source Title	Book Series Title	Book Series Subtitle
Document Type	Conference Title	Conference Date	Conference Location	Conference Sponsor
Author Keywords	Keywords Plus	Abstract	Addresses	Reprint Addresses
Researcher ID's	ORCIDs	Funding Orgs	Funding Text	Cited References
Times Cited	WoS Core	Times Cited	All Databases	180 Day Usage Count
Publisher	Publisher City	Publisher Address	ISSN	eISSN
Journal Abbreviation	Journal ISO Abbreviation	Publication Date	Publication Year	Volume
Part Number	Supplement	Special Issue	Meeting Abstract	Start Page
Article Number	DOI	Book DOI	Early Access Date	Number of Pages
Research Areas	IDS Number	UT (Unique WOS ID)	Pubmed ID	Open Access Designations
Hot Paper Status	Date of Export			

Appendix B - Document co-citation clustering information: 5 clusters (Own source)

	ARTICLE		MEASURES						
Cluster Name	Citation Count	APA Reference	Burst Value	Burst Begin	Burst End	2001-2021	Degree of Centrality	Betweenness Centrality	Sigma of Newness
Cluster 0 (Open Foresight) Cluster Size (Reference): 72 Cluster Silhouette: 0,905	47	Rohrbeck et al. (2015)	13,82	2017	2021		18	0,02	1,29
	22	Heger & Rohrbeck (2012)	6,79	2014	2017		25	0,03	1,25
	21	Ruff (2015)	6,40	2017	2019		16	0,01	1,07
	17	Heger & Boman (2015)	4,87	2017	2021		37	0,04	1,22
	12	Van der Duin et al. (2014)	4,83	2017	2019		27	0,00	1,02
	15	Boe-Lillegraven & Monteverde (2015)	4,29	2017	2021		20	0,01	1,03
	18	Vecchiato (2015)	3,76	2017	2021		31	0,06	1,24
	13	Paliokaite & Pačesa (2015)	3,71	2017	2021		19	0,02	1,07
	10	Rhisiart et al. (2015)	3,62	2018	2021		5	0,00	1,00
Cluster 1 (Rich Tradition) Cluster Size (Reference): 64 Cluster Silhouette: 0,861	34	Rohrbeck & Gemünden (2011)	10,57	2013	2016		24	0,02	1,28
	34	Rohrbeck & Schwarz (2013)	8,73	2015	2018		17	0,02	1,16
	24	Rohrbeck (2012)	7,42	2014	2017		35	0,05	1,48
	20	Vecchiato & Roveda (2010)	7,36	2012	2015		20	0,03	1,21
	17	Vecchiato (2012)	6,54	2014	2016		25	0,03	1,24
	15	von der Gracht et al. (2010)	6,12	2013	2015		14	0,00	1,01
	19	Rohrbeck (2011)	5,92	2014	2016		27	0,02	1,11
	17	Battistella (2014)	4,30	2015	2018		20	0,01	1,06
	21	Vishnevskiy, et al. (2015)	3,71	2016	2019		20	0,02	1,07
	10	Battistella & De Toni (2011)	3,65	2012	2015		30	0,05	1,18
	9	Bezold (2010)	3,28	2012	2015		17	0,01	1,04
Cluster 2 (Research Opportunities) Cluster Size (Reference): 61 Cluster Silhouette: 0,934	20	Rohrbeck & Kum (2018)	8,97	2019	2021		30	0,07	1,90
	17	Iden et al. (2017)	6,20	2019	2021		19	0,01	1,06
	10	Højland & Rohrbeck (2018)	3,62	2018	2021		12	0,01	1,05
	9	Gershman et al. (2016)	3,26	2018	2021		14	0,01	1,04
Cluster 4 (Way Finding) Cluster Size (Reference): 31 Cluster Silhouette: 0,938	10	Bootz (2010)	4,06	2013	2015		17	0,02	1,11
	6	van der Duin & den Hartigh (2009)	3,59	2013	2014		13	0,01	1,05
Cluster 7 (Proposal) Cluster Size (Reference): 28 Cluster Silhouette: 0,968	8	Gnatzy et al. (2011)	3,24	2013	2015		15	0,02	1,08