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The contribution of BCM to supply chain performance under disruption: a resilience perspective

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ABSTRACT

Purpose: The main aim of this research is to investigate the influence of BCM on the focal company's performance in face of supply chain disruptions. Hypotheses regarding the BCM contribution on supply chain performance loss and vulnerability reduction are built and quantitatively tested.

Design/Methodology/Approach: The data set of Supply Chain Resilience Report (2017) which design by Business Continuity Institutes is used as an input for our analysis. The theoretical framework has been designed and supply chain resilience constituents considered as a theoretical lens. Partial least square-based structural equation modeling with reflective construct for both exogenous and indigenous variables, as an overall approach and preliminary statistical analysis are implemented though SmartPLS3 and SPSS software respectively.

Main Findings: Results demonstrates that BCM positively influence the focal company's performance in face of supply chain disruptive events through reduction of SC performance losses and vulnerability. The insurance coverage towards the disruptions has a significant positive relation with reduction of SC performance losses and vulnerability. Also, the key role of top management commitment to BCM is affirmed by enhancement of supply chain resilience constituents that subsequently improve the SC performance.

Research Limitations/Implications: The data set used in this dissertation was the result of BCI questionnaire which already design which constraint the possibility of addressing all elements of supply chain resilience. Therefore two constituents such as flexibility and redundancy are not taken into account. Accordingly, some of the exogenous variables are constructed by only one question which caused lack of generalization capability.

Practical Implications: The study provide the awareness regarding the BCM implementation and its multifaceted effect on both continuity and resilience that leads to better proactively handling such disruptions and proposing the risk mitigation strategy by managers. Furthermore, the findings of this research underscore how BCM improve the SCRES capability, which has mitigation power on detrimental consequences of disruptions, lead to better achievement of SC performance. More specially, mutual collaboration with suppliers, SC risk management and SC visibility can help managers in counteracting the disruptive events and creates proper condition for them to shape their continuity and resilient approach. Finally, it is of relevance for SC managers to understand the attributes of BCM as comprehensive and integrative concept which has excellent potential for conducting along with SCM in order to better mitigate the effect of SC disruptions.

Keywords: Business Continuity Management (BCM), Supply Chain Resilience (SCRES), Business Continuity Plan (BCP), Supply Chain Management (SCM), Supply chain disruption, Supply chain performance, BCM maturity model.

CHAPTER 1

INTRODUCTION

1.1 Dealing with disruption in global and complex SCs

The past few decades have been notable for major changes in Supply Chains (SCs) due to an increasing level of globalization and a higher rate of innovation. The growing role of global SC was associated with increased interconnectedness among different actors in SCs such as customers, manufacturers and suppliers which led to higher dependency among firms in the supply chains and a higher level of supply chain complexity. Companies began to expand, outsource and collaborate with different suppliers at large distances, which has led SCs increasingly exposed to divers source of disturbances and in general become more vulnerable than before (Bevilacqua et al., 2018). Whether the company is small, medium or large, and despite its industry sector, it is reasonable to expect that there is a supply chain disruption looming sometime in the near future. For instance, the BCI supply chain resilience report 2017 depicted that majority of organizations (65%) have experienced at least one disruption during one year. In this vein, Unplanned IT or telecommunications outage (59%), Cyber-attack and data breach (40%) and Loss of talent/skills (34%) are determined in BCI supply chain resilience report 2017 as the main cause of disruption which highly impact supply chain performance. Therefore, being always prepare for a SC disruption is a need which most of the companies should keep in mind as a strategy to mitigate the detrimental effects of their supply chain disruptions towards their performance. The recent history provides several examples of disruptive events which considerably affected single organizations, entire SCs and even put an entire industrial system in a unstable condition. Those disruptions can arise from natural events (e.g. earthquakes, floods, and hurricanes) or manmade events (e.g. accidents, wars, terrorist attacks, strikes, or sabotage). Manmade disruptions can be further classified into those that are deliberate (e.g. hacking) or accidental (e.g. fire at a plant) (Wagner and Neshat, 2010). Moreover, the origin of disruptions could be internal or external to the SC. Internal sources include events such as a machine break down, lack of coordination between supply chain trading partners, or a loss of a supplier;

external disruptions, like natural disasters, are in general more difficult to manage and forecast (Christopher and Peck, 2004a; Ponomarov and Holcomb, 2009).

On March 11, 2011, a 9.0 magnitude tremor hit northeastern of Japan. The earthquake generated a 10-meter-high tsunami that damaged various locations along the coast, including two nuclear plants in Fukushima which has an estimated of US$300 billion as damage cost (Yossi Sheffi, 2015). The production shutdowns at many production facilities resulted in global supply chain shortages of items like semiconductors and car parts. One of many companies detrimentally affected by that phenomena was Toyota. Four plants were affected and consequently the production of parts and vehicles was impacted. According to the employed business strategy such as core competencies and cost reduction, Toyota had adopted a single-source supplier which led to the interruption of production because of disruptions in SC. In the following months, Toyota declared a 50% decline in production at its Japanese manufacturing facilities, along with severe production cuts in North America and China due to SC problem. In addition, at that time, it was predicted that the company could suffer a net loss of $12.2 billion in the period of April to June (Carvalho and Ishikawa, 2016). Another example is the Hurricane Katrina with the estimated financial cost of US$156 billion and it destroyed more than one million acres of commercial timber at in to an estimated cost of US$5 billion (Vigdor, 2008). Equally, manmade disasters are considerably disruptive, for example in the 1998 General Motors' strike involving parts plants disrupted production at 26 different assembly plants (Snyder and Shen, 2006). In 2001, the supply chain disruption caused by an 8 minutes fire at a Philips semiconductor plant resulted in a € 400 million loss for Ericsson who relied on those parts for their consumer products (Rice and Sheffi, 2005b; Tang and Tomlin,, 2008). Typically, disruptions create a domino effect and their detrimental consequences escalate at the both upstream and downstream level of SC (Donadoni et al., 2018). The relevant example in this context would be Tohoku earthquake and the consequent tsunami in Japan in 2011, the harmful effects of such catastrophe struck not only the Japanese economy but also other countries due to the spread out of negative repercussions into global supply chains (Joseph Fiksel, 2014). Toyota's parts suppliers were unable to deliver parts at the expected volume and time and this forced Toyota to halt production for several days. In similar manner, General Motors was forced to stop production because of a shortage of raw materials from their Japanese suppliers (Huffington Post, 2015). Increasing trend of disruptive incidents, encouraged the firms to create and customize their own Business Continuity Plans (BCP) and Management process (BCM) in order to mitigate the detrimental effect of those events in a comprehensive and effective way (Torabi et al., 2016). Therefore, BCM has become a topic of interest among firms due to its capability to identify and mitigate the disruptions-affected business continuity and SC performance. In this vein, BCM identifies possible internal and external threats/risks and their impact to business processes and SC performance as well by providing a framework to organizations in order to properly prepare for unexpected and catastrophic events and capable them to overcome the contingencies (ISO 22301, 2012). As a matter of fact, the comprehensive BCM approach is not just restricted to recovering from disasters such as fire, flood or information system failure, but has also the capability to overcome problems, regarding crucial suppliers or customers, frauds, unethical operations and organizational reputation. From executive stand point, BCM activities is intended to support the decision-making and actions in order to avoid, confront and recover from a disruptive crisis consistent with strategic intent.

Through implementing a Business Continuity Management System (BCMS) which in general aims at reducing the consequences of hazardous events, suitable Business Continuity Plans (BCPs) are provided to respond to possible incidents (that could damage the organization's resources) in an efficient and effective way (Torabi et al., 2016). In this way, BCM could be viewed as a risk management system that enables organizations to improve their organizational resilience level. However, risk assessments are often used as a tool in order to increase their knowledge and awareness about potential negative events as well as to provide decision support for risk reduction, voices and level of criticality have been raised that traditional risk management, supported by event-oriented risk assessments, is not always the optimal tool when it comes to those events which characterized by low-probability/high-consequence (Hassel and Cedergren, 2019). As a matter of fact, the BCM is extended from just recovery process to an integrated management methodology through consideration of business interruption risks identification, strategic and tactical plans definition , proactively management and preparedness to respond in a most continuous way (Faertes, 2015). By taken in to consideration the fact that BCM concept mainly is based on the International Organization for Standardization (ISO) standard 22301, it enables the organizations and their SC to adopt a continuous improvement (Filipović et al., 2018). Additionally, BCM represents crucial basis for generating value and achieving competitive advantage in SCs due to offering organizations a strategic process and resilient approach to improve continuously in event of crisis or disaster (Herbane et al., 2004a). As a consequence, the BCM become extremely popular as an operationalized tool for firms and their SCs to boost their resilience and is an alternative, sometimes supplementary, to traditional risk assessment and management in context of SCM and resilience evaluation. In short, the goals of BCM include contingency planning, crisis management and recovery and the willingness of companies to respond to unsystematic and crisis situations, depends on how successfully firms and their SC adopt the culture of business continuity and prepare BCM requirements not only in organizational level but also expanding the concept of resilience in SCs level. "In an ever-more interconnected world, no organization can retain a competitive position and survive disruptions as an independent entity"(Bhamra et al., 2011). With this regard, the resilience of one party in a SC is central for the resilience of the overall relationship and supplier resilience turn out to be a critical tent in order to protects the whole SC from disruptions (Tang and Tomlin, 2008). In order to better address SC vulnerability and reduce the risk, SC must be multidisciplinary and multidimensional designed to incorporate event readiness, provide an efficient and effective response and be capable of recovering to their original state or improved state after a disruption (Soni et al., 2014). According to the World Economic Forum, 80% of the firms reported that criticality and necessity of resilience to supply chain disruptions has become a top priority (World Economic Forum: Global Risks 2014). Since supply chain disruption can be so harmful and costly, the understanding on how companies should manage disruptions, has become an important topic of discussion and research for both scholars and practitioners (Ponomarov and Holcomb, 2009). The importance of building resilience to deal with supply chain disruption is therefore evident. In general, companies which implemented resilience practices, are less vulnerable to supply chain disruptions and are able to mitigate their consequences .(Ambulkar, 2015). Resilience allows companies to manage disruption without suffering extreme consequences and it helps to carry out continuously the normal flow of operations. Therefore, understanding resilience concept has become even more important due to the growing number of threats can undermine SCs performance and the idea of Supply Chain Resilience (SCRES) has received more attention among recent years.(Joseph Fiksel, 2014). The importance of cultivating SCRES concept is considered as one way to provide not only the mitigation effect of disruptive events, but also has been shown as an effective, yet underdeveloped, strategy in face of the disaster (Zavala et al., 2019). Moreover, as the possibility of it returning back to its original form after deformation is still "theoretical", "many organizations still lack the awareness that it is necessary to take into consideration a resilient supply chain as part of their strategy when developing their risk and continuity management" (Christopher and Peck, 2004a).

1.2 Scope, Objectives and Research Question

As stated earlier, the need for implementing comprehensive BCM approaches and systems is increasing due to various source of disruptions and their so-called "butterfly effect" which extremely threaten both firms and their SCs performance. Mainly, improving performance of focal companies when their SCs suffer from detrimental disturbance, encourage the firms to take advantage of BCM. Since the SCRES concept is one of the most effective procedures in terms of SCM and especially when the improvement of SC performance and reduction of vulnerability under the disruptive events is the aim of evaluation, the term "continuous improvement" should be taken into account. However, digging into the existing literature related to BCM, different general contributions have been provided which described tools and methods related to BCM for dealing with disruptions. For instance, BCM planning with especial focus on internal and external information security is proposed by (Cerullo and Cerullo, 2004), the necessity of BCM implementation in organizational resilience (Zsidisin et al., 2005), the application of BCM planning for evaluating the organizational disaster preparedness at Boing done by (Castillo, 2005), the development of the BCM maturity model in field of banking and financial SC was studied by (Randeree et al., 2012a), there is still lack of studies which taken into consideration BCM and SCRES simultaneously. The Figure 1.1 shows the supply chain network structure, two relative and critical concepts which are the pillars of this thesis and the possible disturbance which threaten supply chain of focal company.

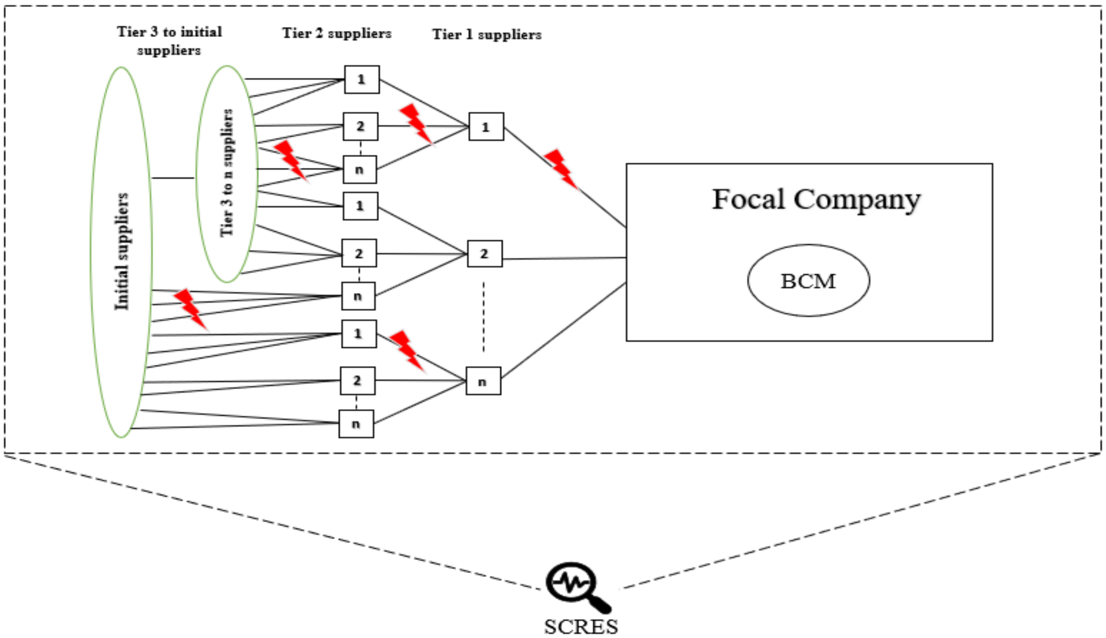

Figure 1.1: Overview of research elements

In this context, the main scope of the research is related to BCM and considering SCRES as a theoretical background, since the importance and influence of this concept are already investigated and recognized as an effective theoretical background when disruptions happened. Due to the lack of investigations in terms of conceptualization and empirical studies on BCM constructs and its contribution to focal company's performance in confrontation with disruptive events at supply chain level, the main aim of this research is to address systematically this research gap by answering the following research question:

RQ: How does BCM influence the focal company's performance in face of supply chain disruptions?

In line with the research objective, this thesis used quantitative research methods in order to answer the research question. The study relies on the full dataset of the Business Continuity Institute (BCI) Supply Chain Resilience Report (2017) which is one the most well-known and mature investigation towards business continuity and SCRES. Data was acquired in Excel spread sheet format and preliminary analysis such as encoding was done to prepare the data in a structured way for further analysis. Besides, the SCRES perspective (as a theoretical lens) was considered in order to understand the role and influence of BCM components on firm's performance under supply chain disruption. To this end, the conceptual remapping matrix of the BCM and SCRES constituents was created to transform the BCM components into SC resilience constituents. We expect that answering the research question will shed light on how different BCM activities and practices (components) contribute to the reduction of SC vulnerability and to the enhancement of firm's performance when a supply chain disruption event occurs.

1.3 Structure of the Thesis

This thesis is organized into five chapters, followed by the references and appendices.

Chapter1, introduces the study and establishes the field of SCM and the criticality of the various disruptive events and hazardous which jeopardize the SC are described. In particular, it provides a background to the current discipline of SCRES and BCM concepts and their necessity to consider them in a more holistic way with providing some famous examples. It then introduces the scope, aim and objectives of research and the gap which this research is identified and present the research question. This chapter also briefly outline the methodology and theoretical framework applied for this study and finally concludes with brief explanation of each chapter.

Chapter2, examines the literature relating to theories underpinning this research and establishes the knowledge gap in this field of study. It begins by exploring the diverse definitions of BCM and reviews current thinking on how to best manage a BCM program within an organization. It then develops a BCM maturity model matrix and derives a comparative benchmark of design elements sourced from both the academic literature and the literature of 'best practice' standards. The dependent literature fields of business continuity planning, emergency response management and disaster recovery planning are then examined, providing context on how they are critical components of an effective BCM program. The review then briefly addresses the formative relationship with risk management and goes on to describe the interrelationship with crisis management, emergency management and service recovery, qualifying how they have affected the evolution of BCM practice. The final literature field focuses on BCM in the public and local government sectors and confirms the scarcity of literature on BCM in the small to medium enterprise field and in the local government discipline.

Chapter 3,This study used a range of theoretical perspectives to both inform the study and address the research question. A theoretical/conceptual framework may be defined as the concepts and theories that support and inform one's research. Put in more simple words, it is the 'theory about what is going on, what is happening and why' (Robson, 2002). To identify the conceptual/theoretical concepts underpinning this research project, the researcher drew on a range of theoretical resources, which mainly including works on BCM concept, maturity model of BCM and its relevant components, SCM under the disruptive events, SCRES constituents, SC performance and vulnerability, as they provided context for the inception and major influencing factors regarding the development of research aim and objectives. Since the influence of BCM method on SC performance is the core point for this research; the resilience building construction is done through mapping the BCM components against the SCRES constituents based on the existing literature. Thereafter, the theoretical models including the SCRES components (inherently reflect and gained by BCM concept) and their Hypotheses (HPs) are defined for both SC performance and vulnerability (target variables).

Chapter 4, The epistemology or philosophical grounding for this research is constructionism. It is crucial that the underlying philosophy is made explicit, since it underpins the research design and how the researcher approached the research questions. Social constructivism considers that people construct knowledge between them; in other words, that 'meaning is not discovered, but constructed' (Crotty, 1988). It is a subjectivist perspective under which the goal of the researcher is to collect and analyze the participants' 'view of the topic under investigation' to create meaning and understanding. Thus, constructivists assert that there are multiple realities, that these realities are socially constructed and that investigating these realities from multiple perspectives will generate divergent and rich inquiry. Subsequently, this study reflects the constructivist paradigm, as the objective was to explore and understand the contribution of the BCM methodology on SCM in general terms from resilience perspective. The data which used in this study for analysis is from BCI supply chain resilience report 2017. The data-analysis techniques included categorizing, describing and synthesizing the data. Open coding was used in the first stage of data analysis to locate themes and assign category titles in order to be consistent with the software input requirement. Conducting preliminary analysis include the statistical descriptive analysis is done to illustrate the general perspectives of the questionnaire. Afterward, based on assigning the coding, the Partial Least Square (PLS) Structural Equation Model (SEM) based on the reflective model for both exogenous and endogenous variables is applied with PLS.3 software.

Chapter 5: Details the findings of both models regarding the PLR and VUR and relevant explanation regarding the statistical procedure are illustrated. This chapter, represent separately outcome of PLS software for each model that included the path coefficient and bootstrapping methods which lead to assessment of proposed hypothesis in research framework. Finally, the chapter illustrates the summary of PLS-SEM models analysis table and each hypothesis component.

Chapter 6: Provides discussion on the findings in reference to the research question and the relevant hypothesis. For the sake of simplicity each hypothesis is recalled and the major outputs are critically discussed. The sufficient proofing and confirmation are provided regarding the influential role of BCM in boosting the supply chain performance in order to support each hypotheses and depicts the finalized assessment table regarding the accepted or rejected hypothesis.

Chapter 7: The final chapter provides the conclusion for the study. It first explain the summary of scope, aim and finding which obtained though this study. Then it presents the theoretical and methodological research contribution and articulates the implications for professional practice of using the BCM outcomes developed in enhancing the SC performance in face of disruption events. Finally, the significance of this research in the field of BCM includes an outline of the limitations of the current study and potential future research opportunities stemming from this work are provided.

CHAPTER 2

LITERATURE REVIEW

This chapter is devoted to reviewing the state-of-the-art of existing knowledge on BCM and SCRES, to set the theoretical background for the study upon which building a comprehensive theoretical framework.

2.1 State-of-the-art review on BCM

2.1.1 Search methodology

The literature review analyses the existing body of knowledge and follows two purposes. Firstly, it defines the context and set the theoretical background, providing the reader with a comprehensive understanding regarding the core elements of the subject. Secondly, it serves to identify existing knowledge gaps that could be addressed and thus filled by the contribution of the present study.

In order to ensure an adequate coverage of pertinent literature, relevant academic and practitioners' contributions were searched and selected through a systematic search and selection process. Mainly focusing on scientific papers published on peer-reviewed journals or indexed conference proceedings, the search was performed independently in different online databases, Scopus, Web of Science, IEEE Explore, Emerald and Science Direct. Based on the topic of this thesis, the keywords which illustrates in table 2.1 search in order to understand the general view of two fields which investigated in this research.

Table 2.1: Field and keywords

Field	Keywords
Business Continuity Management	BCM, BCM method, BCM framework, Continuity management, BCM model, BCM program, BCM planning, BCM constituents, BCM maturity model.
Resilience	Resilient supply chain, supply chain disruption, resilience capabilities, supply chain resilience, supply chain performance.

Furthermore, to find out cross- sectional, the key words combination separated by the Boolean operator "AND" is applied such as, "BCM" AND "Supply Chain", "BCM" AND "Supplier", "BCM" AND "Resilience", "BCM" AND "Framework". "BCM" AND "Maturity Model", "BCM" AND "Supply Chain Resilience".

2.1.2 BCM from practitioner's perspective

Business continuity is a management process which addresses the different critical factors of survival organizations and ensure the continuity concept in both operational and organizational level. The evolution of BCM from regulation and standardization perspectives can be described by five historical phases, which the first four are investigated by (Herbane, 2010a) and the fifth one is related to the current landscape of BCM implementation (2012 till present). Table 2.2 illustrates the five phases and relative drivers, practices and nature of progress and the explanation of each phase is provided below.

Table 2.2:Development of business continuity management (Herbane, 2010a)

Phase	Time period	Drivers	Practice	Nature of progress
1	Mid-1970s → mid-1990s	Emerging legislation	DRP, BCP	Development
2	Mid-1990s → 2001	Emerging standards	BCM	Development
3	2002 → 2005	Acceleration and focus	BCM	Diffusion
4	2006 → 2011	Competing standards and breakout	BCM	Local standardization
5	2012 →	International standardization	BCM	International standardization

<u>Phase 1 - Emerging legislation phase:</u> It could be considered as the foundation for the introduction of Disaster Recovery Plan (DRP) and the BCM in organizations and initiative forcing companies to consider disaster recovery and business continuity related issues came

from the US, where the Flood Disaster Protection Act was introduced in 1973 (Junttila, 2014). Finally, in the 1990s, the establishment of new regulations required stronger control for the protection of critical assets, incident response strategies, availability of critical processes, and contingency planning.

Phase 2 - Emerging standard phase : Although the importance of business continuity for certain industries was recognized during the emerging legislation phase, it was not until the second phase, the emerging standards phase stretching from mid-1990s to 2001, when the first standards emerged bringing business continuity into the focus across industries and also outside the US (Junttila, 2014). During this period (mid-1990s to early 2000s), there was a predominant development and initially awareness of standards to guide the BCM process and different initiatives took place. In the beginning, BCM was just part of the standards, however, over the years it took a more important role. This period of time is distinguished by two fundamental changes firstly, the upgrade of the earlier standards is provided, secondly, through the application of the ISO/IEC directives, local standards became international standards.

Phase 3 - The post-9/11 phase: The terrorist attacks on September 11 in 2001 further shaped the practice to include organization-wide resilience and more flexibility to the planning to better support larger disasters (Herbane, 2010a, 984). Additionally, two of the most well-known business continuity institutions, the Business Continuity Institute (BCI) in UK which published and its US counterpart, the US Disaster Recovery Institute (DRI), were formed, further supporting the business continuity management in being recognized as a management discipline (Herbane, 2010b).

Phase 4 - Internationalization phase : Based on the study of (Herbane, 2010a), this period is witness of two important process in terms of internationalization in sense that, firstly National standards became international standards , secondly International organizations took a stronger role in leading this breakout. The benefit of the international standards was providing the new road map for organizations to be more resilient and achieve international certifications. In this context, one the most popular standards was published by British Standard in 2006 was BS 25999 ,which for many years it was an acceptable standard for BCM, helped organizations to start adopting a holistic BCM approach (Dominguez, 2016).

Evolution of BCM in the last few years: The occurrence massive natural disasters and the appearance and increase of new cyber threats caused momentum for BCM and the term "resilience" got more and more implications among the business continuity experts, and a new standard came to supersede the BS 25999: ISO 22301 (Dominguez, 2016). In addition, to the new standard, new trends have also appeared as part of the strategies for business continuity which have a considerable effect in organizational resilience. Moreover, contemporary BCM takes a socio-technical approach to the causes and responses of potential crises. These characteristics along with the comprehensive approach where the actions before, during and after a crisis are effectively managed, set BCM a significant tool and widespread applicable for both international and local firms, apart from crisis management, risk analysis and disaster recovery planning disciplines (Herbane, 2010a).

2.1.2.1 Standardization of BCM

Through the history of BCM Two of the globally well-known systems are BS 25999 by the British Standards Institute and ISO 22301 which released in 2012 by the International Standard Organization (Dominguez, 2016). ISO 22301 is the first international standard focused only on business continuity which can be used regardless of size, region, and type of industry (Zawada, 2014). Basically, this standard explained "what" an organization required to take into consideration for a BCM implementation and related to how properly the organizations address these three important issues: management engagement and organizational alignment, program scope, and project versus the program. The different clauses of ISO 22301 approach to the Business Continuity Management Systems (BCMS) as a cyclic process and basically applied the Deming's Plan – Do – Check- Act (PDCA) in BCMS context, which allows organizations to go through an entire process of planning, reviews, and improvements (Dominguez, 2016; ISO 22301, 2012). It has been later on incorporated to other management systems standards such as ISO 9001 (quality management), ISO 14001 (environmental management), ISO/IEC 27001 (information security management) and ISO 28000 (supply chain security management), facilitating a consistent and integrated implementation and operation within these related standards. Figure 2.1 shows how the PDCA model is applied to the BCMS processes.

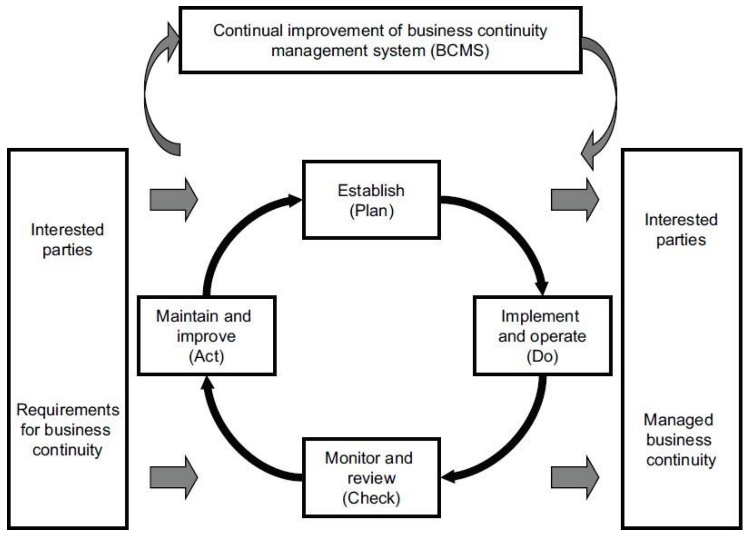

Figure 2.1: PDCA model applied to BCM system processes (ISO 22301 2012.)

The BCMS process in the above figure has interested parties as stakeholders and requirements for business continuity as an input, and after applying the process steps in the PDCA cycle it produces managed business continuity as an output, meeting the business continuity requirements. Basically, as the maintaining and improving step (Act) is performed, the BCMS is continually improved. The ISO 22301 standard defines BCM activities through seven key clauses, which together cover the PDCA cycle: 1) context of the organization, 2) leadership, 3) planning, 4) support, 5) operation, 6) performance evaluation and 7) improvement. The explanation of each step and key relative clauses are presented in table 2.4.

Table 2.3: Explanation of PDCA model and related key clauses in ISO 22301 (ISO 22301 2012)

PDCA step	**Explanation**	**Related key clauses**
Plan (Establish)	Establish business continuity policy, objectives, targets, controls, processes and procedures relevant to improving business continuity in order to deliver results that align with the organization's overall policies and objectives.	1) Context of the organization 2) Leadership 3) Planning 4) Support
Do (Implement and operate)	Implement and operate the business continuity policy, controls, processes and procedures.	5) Operation
Check (Monitor and review)	Monitor and review performance against business continuity policy and objectives, report the results to management for review, and determine and authorize actions for remediation and improvement.	6) Performance Evaluation
Act (Maintain and improve)	Maintain and improve the BCMS by taking corrective action, based on the results of management review and reappraising the scope of the BCMS and business continuity policy and objectives.	7) Improvement

Although the steps in the PDCA model are briefly explained on a general level in the table above, the related key clauses deserve a further explanation as they form the core of the BCMS in the ISO 22301 standard. In the following, each of the seven key clauses are explained to give a comprehensive understanding of the standard.

- Context of the organization:

The first key clause sets the scope for the BCM activities through emphasizing the strategic alignment between the business continuity objectives and organization's values, mission and objectives (Germain et al., 2012). As part of this planning activity, an organization should identify and document its activities, functions, services, products, partnerships, supply chains, relationships with interested parties and the potential impacts related to disruptive incidents. Furthermore, connections between the business continuity policy and other policies such as overall risk management strategy should be identified as well as the organization's risk appetite (ISO 22301 2012, 9). In order to define the scope for the BCM, the organization must identify the interested parties and their needs and expectations regarding the BCMS (ISO 22301 2012, 9). If some part of the organization is excluded from the BCM scope, it has to be made sure such exclusion does not affect the organization's ability to provide continuity of business operations as defined in the BCMS requirements (ISO 22301 2012, 10).

- Leadership:

The second key clause "leadership" emphasizes the need for top management and other relevant management roles to show an ongoing commitment to the BCMS (Germain et al., 2012). This part of the clause should affect not only the planning, but every step in the PDCA cycle since the commitment and supporting of executives is important and considering the initiative phase in decision making process. In addition, establishing a business continuity policy in the organization belongs also to this clause. The policy should provide a framework for setting the business continuity objectives and it should align with the purpose of the organization. On the one hand, it should include a commitment to satisfy the applicable business continuity requirements and on the other hand it should also include a commitment to continually improve the BCMS (ISO 22301, 2012). The policy should be documented and communicated to the organization. Furthermore, it should be made available to the interested parties as appropriate and reviewed regularly or at least when such changes occur which could affect the validity of the policy (ISO 22301, 2012). In addition to the management commitment and business continuity policy, the leadership encompasses assigning the responsibilities and authorities for relevant roles in the organization. The responsibilities and authorities should cover not only the implementation of the BCMS, but also reporting on the performance of the BCMS to the top management (ISO 22301, 2012).

- Planning:

As the name suggests, the third key clause “planning” forms an essential part of the planning step in the PDCA cycle. With the scope defined in the first key clause in mind, the organization should determine the risks and opportunities that need to be addressed to ensure the BCMS can achieve its intended outcome. Then it should plan the actions required to address these risks and opportunities as well as how these actions can be integrated and implemented to its BCMS. Finally, a plan is made on how to evaluate the effectiveness of these actions (ISO 22301, 2012). Defining the business continuity objectives is an essential part of this key clause. The BCMS objectives express the intent of the organization to treat the risks identified and to comply with requirements of organizational needs (Germain et al., 2012). The objectives should be consistent with the business continuity policy and take account of the minimum level of products and services acceptable to the organization to achieve its objectives. In order to achieve the business continuity objectives, the organization should determine who is responsible, what will be done, what resourced are required, deadlines and measures for evaluating the results (ISO 22301 2012, 12).

- Support:

The fourth key clause “support” forms the last part of the planning step in the PDCA cycle which consists of resources, competence, awareness, communication and documented information. Managing the BCMS requires appropriate resources for each task. Competent staff is required to accomplish these tasks and in this context, support means acquiring the required competency either by training, mentoring, reassigning or hiring employees (ISO 22301 2012, 13). Awareness is another key part of the support clause. Staff should be aware of the business continuity policy and their role during a possible disruptive event. Furthermore, the implications of not conforming to the BCMS requirements should be clear for everyone (ISO 22301, 2012).

- Operation:

This key clause consists of Business Impact Analysis (BIA) and risk assessment, business continuity strategy, business continuity procedures, exercises and testing. Various methodologies exist for performing a BIA, but generally it should identify the activities supporting the provision of products and services and assess the impacts over time for not performing these activities. Further, the dependencies and supporting resources for these activities should be identified, including suppliers and outsourcing partners (ISO 22301, 2012). During the BIA, the organization identifies and systematically analyzes risks of disruption to its prioritized processes, systems, information, people, assets, outsourcing partners and other supporting resources. It is then evaluated which of these risks require mitigation and what kind of mitigation actions are suitable while keeping the business continuity objectives and the organization's risk appetite in mind (ISO 22301, 2012). The order in which the BIA and risk assessment is made depends on the chosen methodologies for these actions (ISO 22301 2012, 15). The BIA and risk assessment produce the requirements for developing the business continuity strategy. The strategy should include how to protect the prioritized activities during normal operation, how to mitigate, respond and manage impacts during a disruptive event and how to stabilize, recover and resume the activities after a disruptive event. The business continuity procedures aim at managing disruptive incidents and continuing the prioritized activities based on recovery objectives identified in the BIA. The business continuity procedures should include incident response structure, warning and communication procedures, business continuity plans and recovery procedures. The procedures should establish an appropriate internal and external communications protocol and specifically determine the immediate steps following a disruption. Furthermore, the procedures should be flexible to respond to unanticipated threats and changing internal and external conditions (ISO 22301 2012, 17-18). The last component of operation, exercising and testing, aims at ensuring the business continuity procedures are consistent with the organization's business continuity scope and objectives by regularly testing them (Germain et al., 2012). The exercises should produce formalized post-exercise reports containing the outcomes, recommendations and actions to implement improvements (ISO 22301 2012, 17).

- Performance evaluation:

This key clause recommends the organization to monitor, measure, analyze and evaluate the effectiveness and performance of the BCMS and to conduct regular internal audits and report the results in management reviews. An organization should evaluate its business continuity procedures and capabilities to ensure they are adequate, suitable and effective. Not only should the evaluation aim at assessing conformance with its own business continuity policy and objectives, but also with applicable legal and regulatory requirements and industry best practices. The evaluations should take place at planned intervals or when changes occur, which could require adjusting the procedures (ISO 22301, 2012). Internal audits should be used to assess whether the BCMS conforms to the organization's BCMS requirements and whether it is effectively implemented and maintained. The trends revealed in the internal audits are reviewed by the top management in management reviews, which aim at ensuring the BCMS"s continuing suitability, adequacy and effectiveness. Furthermore, the management reviews should monitor for changes in external and internal issues that are relevant to the BCMS and consider possible need for changes in the BCMS, including the policy and objectives (ISO 22301, 2012).

- Improvement:

The seventh and final clause "improvement" covers the Act-step in the PDCA cycle. It emphasizes continual improvement, encompassing all actions taken throughout the organization to increase the effectiveness (reaching the business continuity objectives) and the efficiency (achieving an optimal cost to benefit ratio) of the BCMS processes (Germain et al., 2012). It encourages the organization to continually improve the suitability, adequacy and effectiveness of the BCMS (ISO 22301, 2012). The clause defines corrective actions to be taken when nonconformity occurs. It encourages the organization to review the nonconformity, determine its causes and if similar nonconformities exist the corrective actions should be done. ISO 22301 is an answer to many BCM practitioners who were looking for a non-regional standard able to be used in any organization. It represents a change in traditional BCM. ISO 22301 and provides clauses to performance evaluation and improvement. These clauses help organizations to keep tracking, and close gaps that can be found during the testing and exercise process (Ee, 2015).

According to the international organization for standards (ISO), BCM life cycle involves six elements including the business continuity program management, embedding competence and awareness in the culture of organization, understanding the organization, selecting business continuity options, developing and implementing a business continuity response, and exercising and testing the developed plans which shown in Figure 2.2 (ISO 22301, 2012; Torabi et al., 2014).

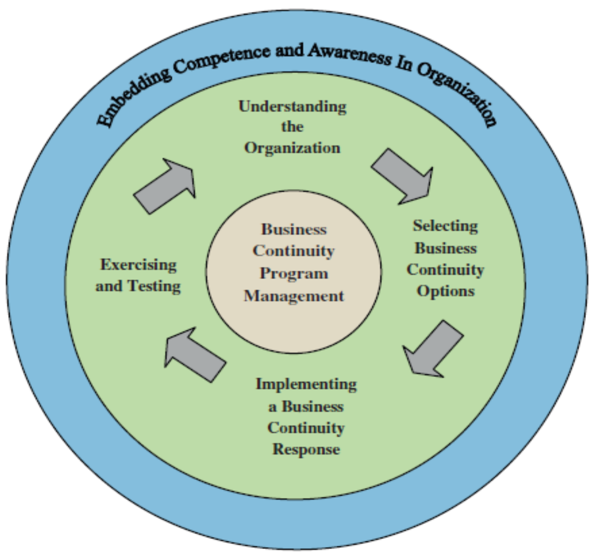

Figure 2.2: The life cycle of BCM

Two main elements in order to better understand the organization approach regarding the BCM and its operational implementation, are BIA and Risk assessment (Torabi et al., 2014). Based on ISO standard, BIA is defined as “a process of analyzing operational functions and the effect that a disruption might have upon them” (ISO 22301, 2012). Therefore, the main objective of BIA is gathering and analyzing required information to codify a report to top managers for preparing business continuity plan (BCP). According to the BCM’s life cycle, the result of BIA providing the list of key products based upon the ranking of the organization's products with their identified critical function (Sikdar, 2011; Torabi et al., 2014).

Basically, the proper BIA analysis should be aligned with the organization's goals without any contradiction with them. In addition, the BCM strategies functions, keep the continuity of the organization and more specifically, emphasized on key functions and critical activates based on the outcome of BIA methods. Basically, the proper BIA analysis should be aligned with the organization's goals without any contradiction with them. In addition, the BCM strategies functions, keep the continuity of the organization and more specifically, emphasized on key functions and critical activates based on the outcome of BIA methods. Therefore, the process of validation of business continuity of the organization is highly depend on how BIA is implemented. . According to the BCM guidebook developed by the International Labor Organization (ILO) for SMEs, BCM consists of three elements: (1) *preventative measures* (e.g. relocate the critical stock in a geographical location subject to lower or no risk of disaster; (2) *preparedness arrangements* (e.g. make an inventory of reliable alternative of supplier ; and (3) *response options* (e.g. contact alternative suppliers in case of supply chain disruption) that shows in Figure 2.4 (Kato and Charoenrat, 2018a).

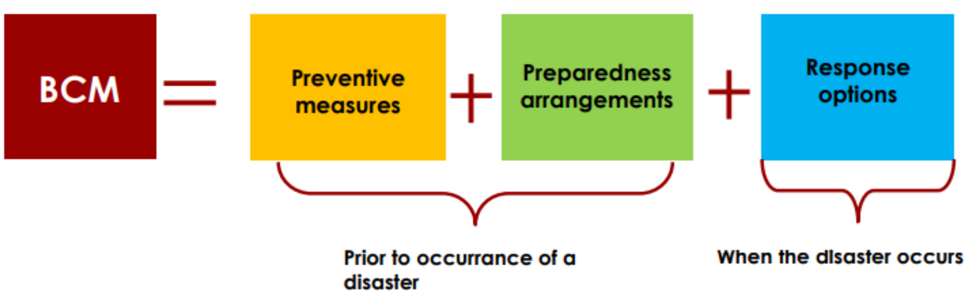

Figure 2.4 BCM elements (Kato and Charoenrat, 2018a)

Based on the guidebook provided by ILO that particularly investigate and propose guidelines for implementation of multi-hazard BCM in SMEs, the key steps along with their deliverables from initial till the ultimate phase is provided in table below.

Table 2.4BCM steps, process and deliverables

STEP	PROCESS STEP	DELIVERABLES
BIA and disaster risk assessment	Determine the Business priority	List of priority products and services
	Identify critical assets	Ranking of critical assets
	Identify time-critical operations	Ranking of time critical operations
	Assess the risks	Risks profiles of assets and operations
Planning	Prepare scenarios	2-3 complementary scenarios
	Design and validate the BCP	BC plans documents for each department
Communications and training	Design and roll out the communications	Communications procedures
	Training on BCM	Seminars and training materials
	Activate and close the BCP	Recovered business operations
	Gather the lessons learnt and adjust the BCP	Revised plans

In this vein, the critical success factors for BCM implementation are well identified and explained in the ISO standard for BCM implementation requirements.

(1) Management support: It is essential that business continuity program to be initiated, sponsored and authorized by senior management and business unit management from the preliminary phase of its implementation and it is a key factor to success of business continuity at every organizations (Bakar et al., 2015a). Generally the senior management support can be accomplished in various ways such as (Bakar et al., 2015a) :

- Defining a central group for taking the BCM responsibility and managing governance.
- Communicating the importance of BCM and how it adds business value.
- Participating in BC exercises, training sessions, and other emergency management events.
- Ensuring appropriate funding for BCM activities implementation.
- Deploy BCM continuous quality program.

(2) Risk assessment and mitigation: The main purpose of this part is to identify likely risks that could disrupt critical business processes performed at specific locations of operation (Bakar et al., 2015a). The BC risk assessment is used to shape the overall BCM program scope by providing a list of likely events and associated consequences that should be addressed in a risk mitigation plan (e.g., prevention) and the BCM program. While , there is no way to predict all risks or to mitigate all known risks that may need to be accepted due to the disruptive very likely and predictive events (e.g. hurricanes and/or utilities failures in some parts of the world, or other regularly occurring events) and events that are somewhat likely to occur (e.g. earthquakes), a proper business continuity plan may include and consider the so-called credible events. As a result, balance is the key to risk management of BC when evaluating disruptive events. Identifying all potential disruptive events which drastically impact the business operations become more critical step in mitigating the exposure of risk (Bakar et al., 2015a). *(3) BIA:* it is used to identify critical business processes and include recovery solutions that need to be recovered following a disaster event. The BIA should be performed with the knowledge from the BC risk assessment that defined the credible events that could disrupt the business. From the organizational perspective, conducting BIA and risk impact assessment and generally, use of BCM standards empower the organizational resilience (Bajgoric, 2014a). *(4) Business recovery and continuity strategy:* Business recovery and continuity strategies must be developed for critical business processes identified during the BIA. Participants in the business recovery and continuity strategy session may include staff from the business, key suppliers, and information systems organizations. *(5) Maintenance*: One of the most common obstacles preventing organizations from obtaining BC readiness is neglect. Frequently, organizations invest great time and expense in developing plans that are never maintained thereafter. Like any operational plan, BC and CM

plans atrophy over time and become less effective as changes in business priorities, people, processes, technology, and operating environment fail to be reflected in the plans. In Figure 2.5 the flow chart of the BCM requirements with the necessary responsibility of each phase is provided.

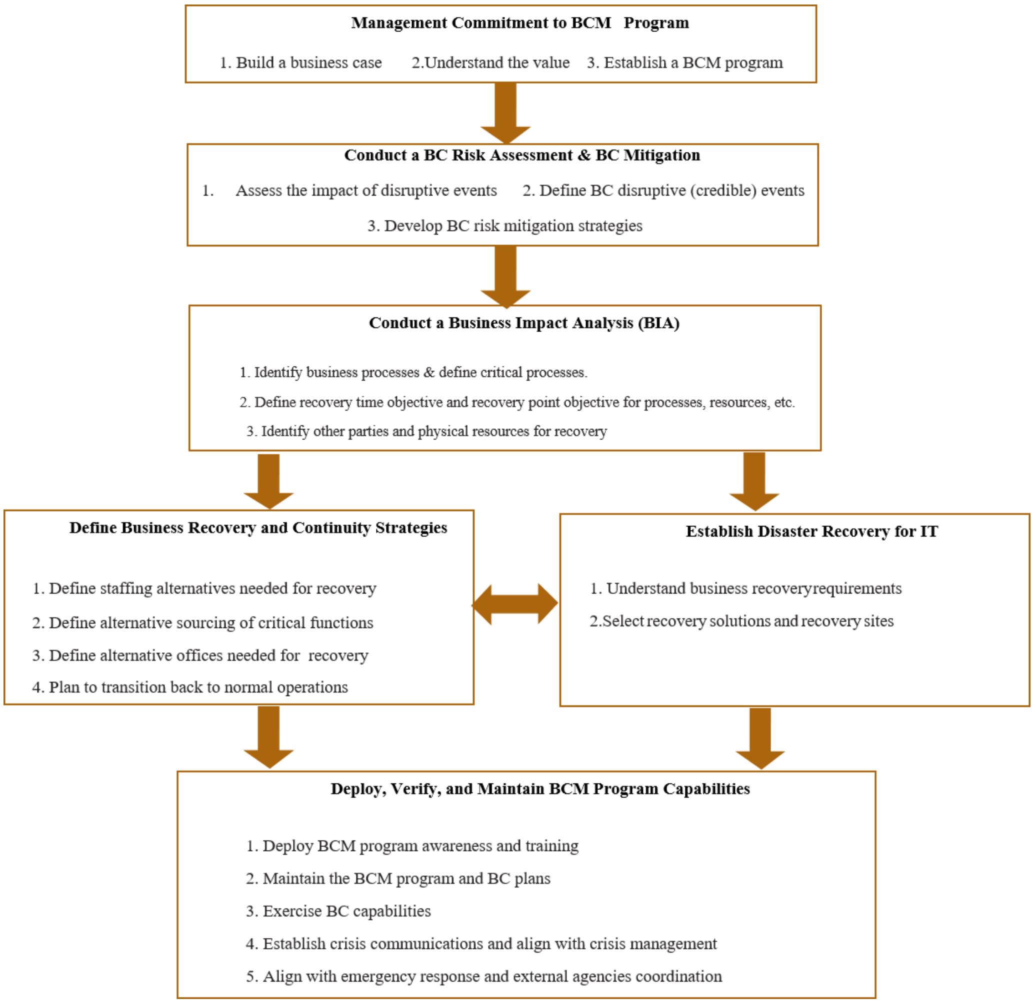

Figure 2.5: BCM requirements flow chart

In addition, the Best Practice Guidelines document (2002) which adapted in Publicity Available Specification (PAS 56) represent the BCM as an umbrella activities which show in Figure 2.6 “that unifies a broad spectrum of business and management disciplines in both the private and public sectors, including crisis management, risk management and technology recovery, and should not be limited to information technology disaster recovery (PAS 56 2003). In general, the framework presented the emphasize on the overall need to have unify functions in order to supporting the BCM.

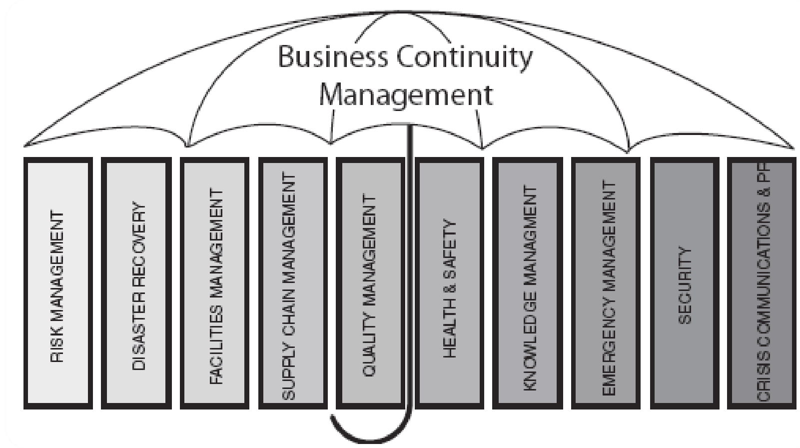

Figure 2.6: BCM umbrella activities

2.1.3 Scientific literature on BCM

Since the main focus of thesis is on BCM contribution to figure out the relative influence on firm performance, there is need to have clear image of what this term actually encompasses and scientifically defined in the literature. The term BCM was introduced for the first time in the end of the 1990's. However, BCM has only recently started to gain substantial momentum within organizations. The Business Continuity Standard BSI 25999 stated: "Business Continuity is the strategic and tactical capability of the organization to plan for and respond to incidents and business disruptions in order to continue business operations at an acceptable predefined level". (Randeree et al., 2012a) indicated that BCM is a management process of critical assets in a way that is possible to guarantee continuity of the critical process in an organization. In the same line as the BCI, (Samson, 2013) defined BCM as an integrated approach to help organizations to react against any unexpected event in an effective and timely manner and goes further in his definition by stated that BCM is a continuous process. In addition, this process is a compound of a series of activities as part of the preparation for an unplanned event, anticipation, and mitigation of the impact of the undesired events, recovery tasks, and evaluation of learned lessons to improve BCM. The definition used by (Smit, 2005a) is: "Business Continuity Management encompasses the management process that aims to prevent severe disruptions in the business and to protect critical processes against the consequences of disruptions or disasters". (Geelen-Baass and

Johnstone, 2008) define it as a "decision-making process aimed at minimizing business loss and maximizing business recovery and continuance following any disaster that may occur at any time". (Herbane et al., 2004a) define it as "a process that identifies an organization's exposure to internal and external threats and synthesizes hard and soft assets to provide effective prevention and recovery". While (Gibb and Buchanan, 2006) see BCM as "a tool that can be employed to provide greater confidence that the outputs of process and services can be delivered in the face of risks". Alternatively, the Australian National Audit Office defines BCM as "the capability that assists in preventing, preparing for, responding to, managing and recovering from the impacts of a disruptive event"(ANAO Australian National Audit, 2009). (Jedynak, 2013) established, BCM as a "permanent and interactive" management process oriented to assure the continuity of critical process at any time. Jedynak stresses the importance of the preparation before, during and after an unplanned event. Disaster Recovery Institute (Disaster Recovery Institute, 2015) defines BCM as "a management process that identifies risk, threats and vulnerabilities that could impact an entity's continued operations and provides a framework for building organizational resilience and the capability for an effective response". (Speight, 2011) defined BCM as "a management process that identifies potential factors that threaten an organization and provides a framework for building resilience and the capability for an effective response". Ultimately the most comprehensive definition of BCM which aligns with the current BCI definition and includes the multiple elements covered by the earlier definitions posed by academics, is that put forward by the standard British Standards Institute (BSI) which states that BCM is "a holistic management process that identifies potential impacts that threaten an organization and provides a framework for building resilience with the capability for an effective response that safeguards the interests of key stakeholders, reputation, brand and value creating activities". Although there is no commonly accepted definition for BCM among the scholars and practitioners, there are some characteristics of BCM that can be encountered in all the definitions and/or the accompanying explanations.

- Ensuring the continuity of business at a certain minimum level.
- Its initiatives should be directed towards the critical business processes;

- It encompasses both the prevention of disasters or disruptions and limiting the damage to business in case of a disaster or disruption, therefore, it has preventive, corrective and repressive characteristics;
- It is a continuous management process, not a single and temporary project.

In Fact, BCM is not only a professional discipline for mitigating the threats, but also a driven issue that unified a broad spectrum of the business and management process that include different field that illustrates in Figure 2.7.

Figure 2.7: BCM relevant elements (Segovia, 2017)

The BCI note that BCM and risk management sit side by side and that the main objective of BCM is to allow organizations manage their business under adverse conditions by implementing resilience strategies, recovery objectives, BCM and crisis management plans in collaboration with, or as a key component of, an integrated risk management initiative. As presented on fig… a key component of risk management framework, basically, the sub-process ,which included in BCM process , such as identification of critical assets and threats, risk management, BCP, Crisis Management, Emergency Management, Service recovery and public sector and local government, makes a BCM as an integrated, never-ending process to guarantee the business and performance resilience (Segovia, 2017). Although, not all risks are the catastrophic events in which firms experience business suspension and interruption, the main focus of BCM is only on those risks that threaten the continuity of critical business operations. (Bajgoric, 2014a) presented a systematic framework for the BCM implementation and proposed the concept of an “always on” business. The model explained that today organizations are using continuous computing technologies to offer to their customers more availability and reliability (Dominguez, 2016). (Faertes, 2015) investigate the current issue related to international and rational standards with main focusing in BCP and illustration of the reliability models on the gas industry and the importance of those implication in order to build BCM programs. In addition, he stated that the reliability and risk management is an essential part for the conception and implementation of BCM programs. The emerging between the concept of BCM and small and medium sized enterprises (SMEs) in Thailand is done by the (Kato and Charoenrat, 2018a) through the data collection in 136 SMEs with designing the questionnaire targeting mainly the top management. Their investigation reveals low level of preparedness for business continuity, including a failure to develop a written BCP and the suggest that perceived disaster readiness, business continuity knowledge and training needs positively correlated with a scale of business size, operation period and disaster experience and demonstrate the equally importance of both public and private sectors in promoting the BCM practices among the SEMs. Additionally, their study also discovered that the main challenges as: limited knowledge and understanding for SMEs in implementing the BCM. Against a background of increasing threats, BCM has emerged in many industries as a systematic process to counter the effects of crises and interruptions, although its potential to play a more strategic role is still largely underexplored (Herbane et al., 2004a). In their paper, mainly the emphasized in strategic aspect of BCM which develops a conceptual approach, in actively ensuring operational continuity, and preserving competitive advantage. (Niemimaa et al., 2019) argue that in order to have a holistic and strategic BCM approach, business models need to become a part of the BC considerations, entailing an expansion of the scope of BC from value preservation to value creation. In their study, the approach of Strategic BCM proposed, which consists of two main parts: (1) sustaining the continuity of the company business model (value preservation) and (2) evaluating and modifying the business model (value preservation) and (2) evaluating and modifying the business model (value creation). (More about strategic role of BCM)]. As (Torabi et al., 2014), stated the importance of understanding the organization, and its key products and processes for the implementation of a comprehensive BCM, All these trends are making organization focus not only in the traditional approach of business continuity, where disaster recovery was the key, but also focusing in the integration of different process and areas of BCM.

(Randeree et al., 2012a) explain the difficulty of ensuring business continuity due to the increasing threats, SC integration and highly dependency in complex information systems. In this situation, the best practice models and methodologies provide could provide information as to how implement the BCM process but do not provide any mechanism to prescribe the extent to which an organization should implement the BCM process. (Boehmer, 2009) presented a model for evaluating the performances of a BCM system according to BS 25999 standard that fundamentally defined performance based on the system's business continuity plans and disaster recovery plans. The study done by (Schätter et al., 2015) in field of food supply chain in Berlin, Germany with focusses on robust decision-making in disaster response where pre-existing logistical structures have not been destructed yet but where a great risk of delayed consequences exists if the functioning of these structures is not strengthened. This paper outlines a conception of a simulation model which combines approaches of scenario-based optimization, stress testing, and robustness measurement. The main point of their conclusion is the positive effects which are provided by BCM of private companies for human safety is an essential step of gaining insight in terms of overtaking the human responsibility under the disruptive events. From governmental stand point, (Kato and Charoenrat, 2018a) heighted the supportive and pivotal role of Thai government in order to creating an enabling environment for spreading BCM practices by SMEs through awareness raising, providing disaster information and practical. (Montshiwa et al., 2015) surveyed the impacts of BCM on 92 automobile parts markers in disaster-prone regions (Asia and North America) and revealed that risk-conscious companies reported better business impact analysis (BIA) and supply chain cooperation status than did non-risk conscious companies and they underlined the importance of BCM in yielding the competitive advantages. In addition, their study state that BIA and risk assessment do not seem to be sufficiently addressing the complex and elaborate nature of supply chain network in the automobile industry. In order to address this insufficiency, they replace the risk assessment with risk ranking method. A quantitative study was carried on 75 automobile parts markers in disaster prone regions (Asia and North America) and the results were analyzed by adopting this modified BCP concept and concluded that BIA is the most important part of BCP as it had the strongest positive total effects on the other BCP factors. In order to minimize the potential of a disaster in the organization (Fasolis et al., 2013) proposes a methodological approach that supports Collective Intelligence towards the design and development of a Business Continuity Plan (BCP). Their results claim that Collective Intelligence is a valuable tool and asset which if collected and used correctly has the potential to not only supporting business continuity for harnessing information and resulting to solutions by reducing uncertainly decision making during or before a disaster, but also lead to design a BCP providing a strategic advance for organization. The recent approaches to BCM has concentrated on adding decision support tools and mechanism to the continuity process or automating the generation of a BCP (Arenas et al., 2015). (Winkler and Gilani, 2011) present a model-driven approach to generate a BCP using model-transformation chains to connect data across the different phases in BCM. (Botha and Solms, 2004) present a BCM methodology consisting of seven phases (project planning, business impact analysis, business continuity strategies, strategies implementation, continuity training, continuity testing, and continuity maintenance), and following a cyclic implementation approach comprising of four distinct cycles (back-up, disaster recovery, contingency planning, continuity planning). The research done by (Labus, 2017) introduced model for adaptive e-BCM in insurance sector. The survey mainly focused on improvements to the establishment of an effective BCM in that sector due to the existing capability of modern e-business technologies: The Internet, mobile computing, electronic services, virtual infrastructure, etc. Generally, their proposed model is the result of both theoretical and practical work in the last few years which leads to defining a framework for establishment and improving the BCM and its key components (BIA, business continuity risk assessment and BCP) in insurance companies. (Kadar, 2015) introduced the concept of BCM risk index. Allowing business practitioners to measure and report the status of the BCM to top management, and align it to the organizational culture. (Tammineedi, 2010) explained the BCM's activities critical for an organization based on a standard approach. These activities are divided into three important phases: before an event happens, during the event, and after the event happens. (Gomez, 2011) underlined the fact that resilience and the continuity of business are factors that rely on sustainable ICT infrastructures. On the other hand, the ICT dimension is not the only factor of implementation and embracing business continuity, rather it involves several non-ICT factors as well that may be crucial for business continuity (staff availability, physical premises, supply chains, etc.) (Bajgoric, 2014a). In this context, (Lavastre et al., 2012) introduced the term of “supply chain continuity planning framework” within the concept of supply chain risk management. (Craighead et al., 2007) considered BC issues within the supply chain mitigation capabilities and supply chain disruption severity. (Bhamra et al., 2011) explained that the level of business continuity in an organization has a direct relation with the resilience level of the organization. They reviewed the concept of resiliency and described that those organizations having implemented BCM and disaster recovery plans, are more resilient than other ones.

2.1.4 BCM maturity models

The maturity model is a staged structure of different levels which determines the extent to which a specific process is defined, managed, measured, and controlled and assuming that the organization develops and adopts new processes and practices in order to move on to the next level, until the desired level is reached (Randeree et al., 2012a). Typically, maturity models have a logical path of levels or stages for a class of objects starting from the initial state and ending to a mature state (Röglinger et al., 2012; Wendler, 2012). The number of levels varies depending on the maturity model, but the difficulty of providing a description for each level as well as the complexity of the model increases along with the number of levels. There is no golden rule as to how many levels a maturity model optimally should have and why (Junttila, 2014), the levels should be conceptualized and theoretically defined as significantly different from each other without any overlapping with each other and should be transferable to an empirical setting. In BCM literature there are maturity models which have been developed by academics as well as by practitioners and consultants. For instance, The Business Continuity Maturity Model (BCMM) by Virtual Corporation (2005), assesses organization’s BCM maturity based on a scale of six levels, of which the first three represent organizations that have not yet met the required BCM program basics to launch a sustainable BCM program, while the latter three represent the evolutionary path to BCM program maturity (Junttila, 2014). An overview of the model is shown in Figure 2.8, where the corporate competencies are viewed on the left column and maturity levels are presented on other columns, increasing in maturity while moving towards the right end of the figure. On each level the degree of engagement in each corporate competency is summarized by the letters H (high), M (medium), L (low) or VL (very low).

The BCMM® Standard Reference Chart — Increasing Business Continuity Competency Maturity →

Maturity Model Levels	Level 1 Self-Governed	Level 2 Supported Self-Governed	Level 3 Centrally Governed	Level 4 Enterprise Awakening	Level 5 Planned Growth	Level 6 Synergistic
Athlete Analogy	Able to Crawl	Able to Walk	Able to Run	"Fit" Runner"	Competitive Runner	Olympic Runner
Comparative Model	Organization "At Risk"		"Competent" Performer		"Best of Breed"	
Corporate Competencies	**General Attributes of an Organization at Each Maturity Level**					
Leadership	VL	L	M	H	H	H
Employee Awareness	VL	L	L	M	H	H
BC Program Structure	VL	L	L	M	H	H
Program Pervasiveness	VL	L	L	L	M	H
Metrics	VL	L	M	M	H	H
Resource Commitment	VL	L	M	H	H	H
External Coordination	VL	L	L	M	H	H
BC Program Content	VL	L	M	H	H	H

Figure 2.8: The Business Continuity Maturity Model

Each maturity level has a description of general attributes of an organization at that level. In addition to the general description, a broader characterization of the overall state-of-preparedness of an organization at each level is provided. The statement pro- vided on the "comparative model" row is supposed to give a quick assessment of how the organization compares against other organizations (Junttila, 2014). Smit's BCM maturity model defines an organization's BCM maturity on two dimensions; process quality and scope. The process quality assessed on a scale of six maturity levels refers to the comprehensiveness of the BCM program, as advancing on the maturity levels requires expanding the process content. This is a major difference to BCMM, in which key BCM process areas were assigned their own maturity dimensions. The first three levels in this model performing on the quality dimension represent BCM evolving from an initiative while in the latter three it evolves into a controlled and optimized process. The scope dimension assessed on a scale of four maturity levels defines the extent to which BCM is exercised in the organization, ranging from single departments and facilities to an organization-wide BCMS (Smit, 2005b) . This model is illustrated in Figure 2.9 which on x-axis, the scope of BCM maturity and on y-axis the BCM process quality maturity is represented.

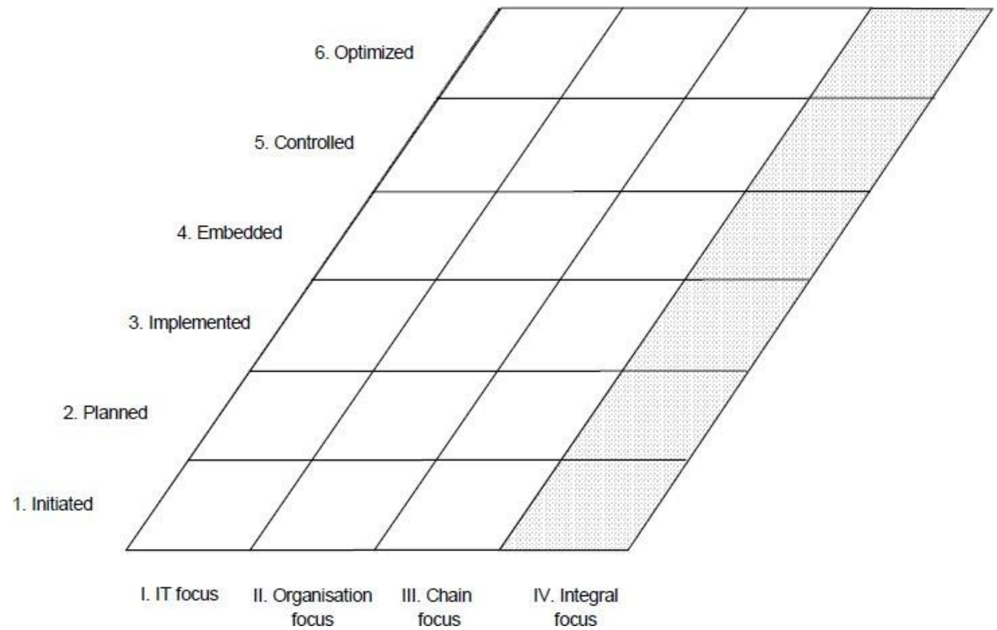

Figure 2.9: Maturity Model for BCM (Smit, 2005b)

The combination of the two maturity dimensions forms a grid which is the basis of the model. Each square in the grid forms a scoped process quality stage (SPQS) with its unique features (Smit, 2005b). As both axes have a cumulative scaling, the maturity of an organization is defined by the rectangle formed of the SPQS"s when the maturity on both axes has been assessed (Smit 2005, 52). In addition to the grid, each maturity level on the process quality dimension has two or three characteristics listed in the level's description. These characteristics for each process quality level can be seen in Figure 2.10 Furthermore, each of those characteristics is elaborated into several specific objectives, resulting in each SPQS, a combination of process quality and scope maturity, having a defined set of objectives (Smit 2005, 52).

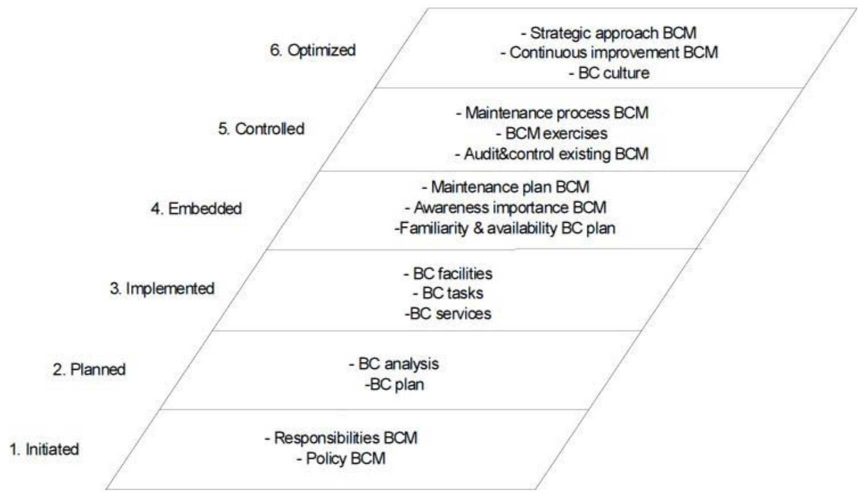

Figure 2.10: Process quality levels and their characteristics (Smit, 2005b)

Another Maturity model is the BCMS capability model (Sheth et al., 2008) which divided in eleven dimensions called capability areas, each of which is assessed a capability level representing the maturity on a scale of one to five (one being immature and five described as "resiliency excellence"). In addition, each capability area is categorized in three requirement silos (good to have, need to have, must have), indicating the importance of each capability area to the organization doing the assessment (Sheth et al., 2008). It is left for the model user to determine the importance of each capability area to the organization. A three-dimensional overview of the model can be seen in Figure 2.11. The 11 capability areas, or dimensions of BCMS, are viewed on the x-axis on the left side, the requirement silos are viewed on the y-axis on the right side and the capability levels representing maturity for each capability area are viewed on the z-axis. The figure represents an example snapshot of the maturity model applied to an IT organization providing services to its end users (Sheth et al., 2008).

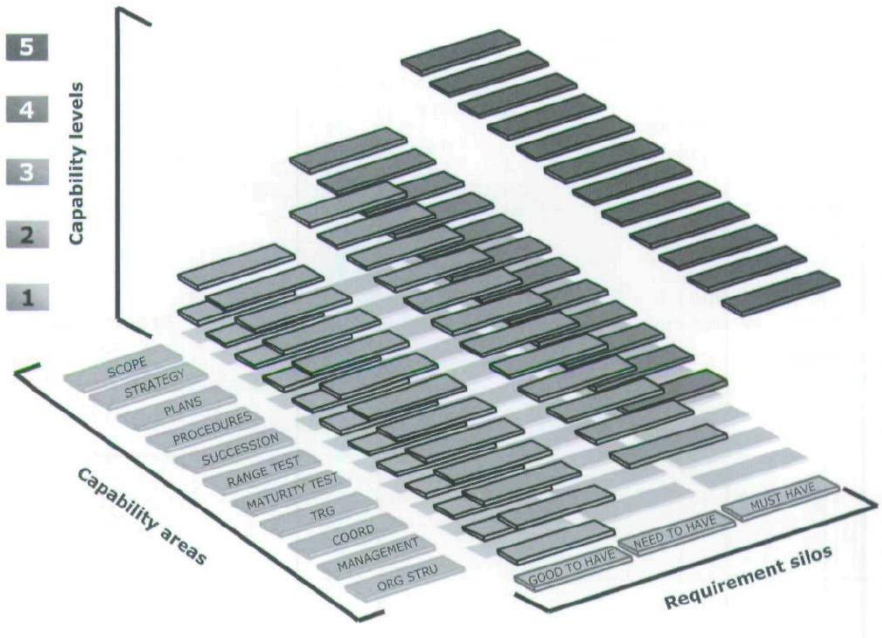

Figure 2.11 :Overview of the BCMS Capability Model(Sheth et al., 2008)

The effect of requirement silos on the final maturity level was not clearly stated in the model and the connection to the assessment results seemed a bit vague. Also the requirements for achieving a certain maturity level in some of the capability areas seemed improperly explained. For example rating the maturity of the plans according to the existence of some specific plans (Sheth et al., 2008) without assessing the quality, comprehensiveness or timeliness of these plans seems inadequate. An example of assessing capability levels in the capability area "plans" can be seen in Figure 2.12.

Figure 2.12: Maturity levels for planning in BCMS Capability Model l (Sheth et al., 2008)

Each of the 11 capability areas are assigned a maturity level, resulting in 11 maturity level assessments which the components in different capability areas are interrelated to each other.

In order to deal with this interrelation, the further mapping was made to determine which capability areas had to mature at the same pace. The resulting cross-capability correlations are shown in Figure 2.13.

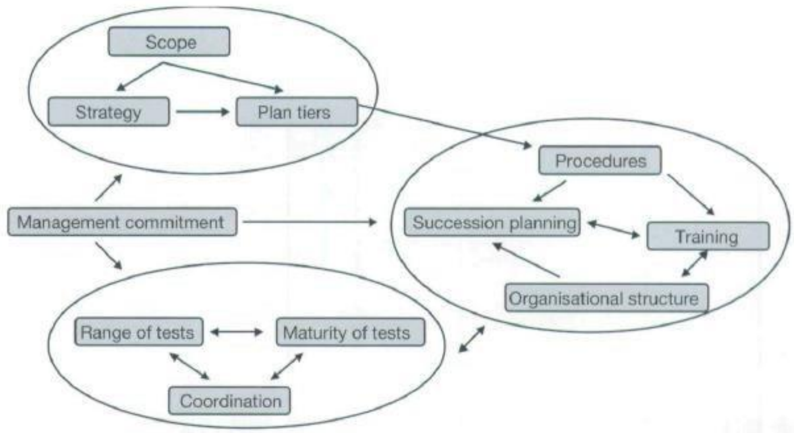

Figure 2.13 : Cross-capability correlations

Lastly, The BCM maturity model by Randeree et al. assesses the organization's BCM maturity through five maturity levels in five dimensions called levels. According to (Randeree et al., 2012a), these levels forming the BCM scope dimension represent 1) technology, 2) facilities management, 3) processes, 4) people and 5) organizational soft issues. The five maturity levels forming the BCM quality axis are called 1) ad hoc, 2) managed, 3) defined, 4) integrated and 5) optimized. The model is can be seen in Figure 2.14. The figure is the same as the original figure presented by (Randeree et al., 2012a), but the levels on scope axis now have corresponding titles included.

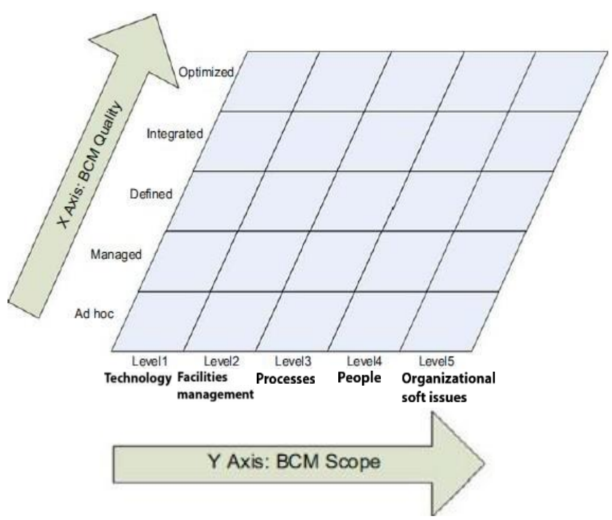

Figure 2.14: Maturity Model for BCM

Although initially the model seems fairly simple and similar to the one by (Smit, 2005b), assessing the maturity levels is not done directly to the scope levels. On each scope level the assessment is made by assessing the maturity of five "areas" representing 1) BCM program management, 2) planning and analysis, 3) development of BCP, 4) implementation and 5) maintenance. The areas and their related maturity levels are shown in Figure 2.15.

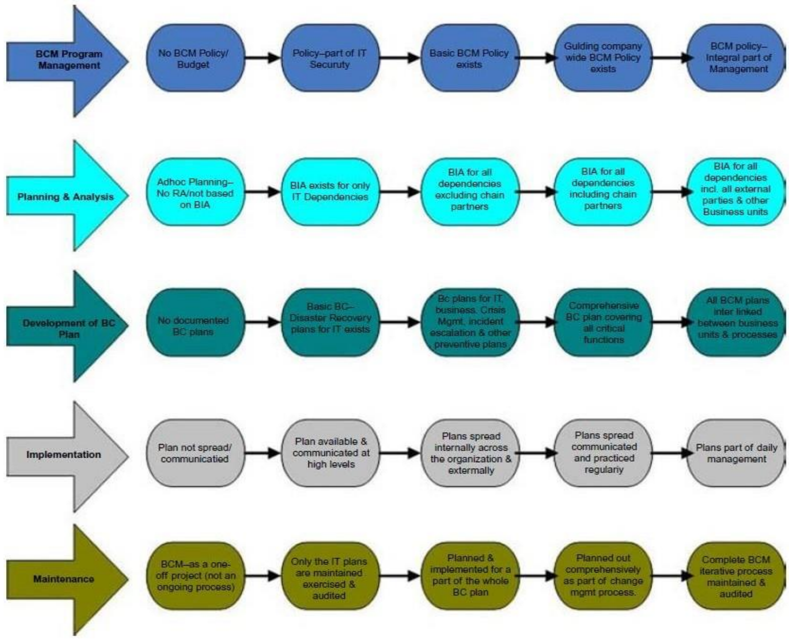

Figure 2.15: Maturity levels of the five areas

Each of the areas contains 2–10 goals (Randeree et al., 2012a). As there are 27 goals in total, completing the maturity assessment on each scope level requires assessing the current state of BCM in the organization against a goal 135 times. Although the maturity assessment proved to have some confusing elements, the BCM coverage of the model is more comprehensive as in the BCMS capability model by (Randeree et al., 2012a). In summary, there were clear differences in the model design processes between models. While the models by (Smit, 2005b) and (Randeree et al., 2012a) proved to be scientifically well-founded in the light of maturity model development guidelines, the model by (Sheth et al., 2008) proved out to lack any tangible documentation of the model design process. In addition to differences in the model design process, there were major differences in the form and function of the models. BCMM and the BCMS capability model (Sheth et al., 2008) had defined 8–11 dimensions or process areas, each having a separate maturity level assessment. The models by (Smit, 2005b) and (Randeree et al., 2012a) relied on two dimensions, the process quality representing comprehensiveness of the BCM program and scope representing extent to which BCM is practiced in the organization. There was also variation in the amount of maturity levels defined in each model, as the maturity models by (Randeree et al., 2012a; Sheth et al., 2008) relied on five maturity levels, while Virtual Corporation (2005) and Smit (2005) had defined the maturation path through six maturity levels. Finally, the conformity of those models to the ISO 22 301 key clauses are summarized in table 2.5.

Table 2.5: Conformity of existing BCM maturity models to the ISO 22301 key clauses

ISO 22301 Key Clause		BCMM (Virtual Corporation 2005)	Maturity Model for BCM (Smit 2005)	BCMS Capability Model (Sheth et al. 2007)	Maturity Model for BCM (Randeree et al. 2012)
1	Context of the organization	+	+	+	+
2	Leadership	+	+	/	+
3	Planning	+	/	/	/
4	Support	+	/	/	/
5	Operation	+	+	/	+
6	Performance evaluation	/	/	/	/
7	Improvement	+	+	/	/

[+] conformity; [/] partial conformity; [-] non-conformity

2.2 Managing Supply Chain disruptions

In a supply chain perspective, a disruption that trigger in one point of the network will have repercussion on the performances of the other organizations starting from the very next link, towards the supply chain and could lead the entire network to fail (Rice and Caniato, 2003). While there are some terms such as “domino effect” and “snowball effect”, most frequently this effect goes under the name of ripple effect (Dolgui et al., 2018; Dmitry Ivanov, 2017; Pavlov et al., 2019). In this context the disturbance is defined by (Barroso et al., 2011) as “a foreseeable or unforeseeable event, which directly affects the usual operation and stability of an organization or an SC”. According to a study conducted by PwC and the Business Continuity Institute in 2013, 75% of companies experience at least one major supply chain disruption a year and majority of the disruptions were caused by supply-related problems. In this context, the ripple effect has been considered as a critical parameter in handling the disruptions (Yoon et al., 2018). Basically, the ripple effect occurs when a disruption, rather than remaining localized or being contained to one part of the SC, cascades downstream and impacts the performance of the SC. The negative consequence of ripple effect might include lower revenues, delivery delays, loss of market share and reputation, and stock return decreases – the cost of all of which could be devastating. More precisely, the ripple effect initiates from comparison with the bullwhip effect which is related to high frequency and low impact risks that are defined as operational risks and is associated to demand and lead time fluctuation. On the other hand, the ripple effect is related to the low frequency and high impact risks that in last decades are a major field of study and are called in literature, as previously presented, disruption risk events. Furthermore, the difference between the two concepts rely also on the affected areas, on the time of recovery and on the performance affected. Starting from the affected areas, the bullwhip effect has an impact on operational parameters like lead time and inventory level. While the ripple effect, given the disruptive nature of the events, has impact on the structural and critical parameter as service level and total cost. About the recovery time, bullwhip effect has usually short recovery time and with little effort of the supply chain to recover, balancing the demand and the supply side. On the contrary, the ripple effect has middle to long term recovery time and to be fully recovered needs coordination efforts and investment from the supply chain. The last dimension of difference, analyzed by (Sokolov et al., 2016) is the impact on performances that are related to the affected areas nominated before. Bullwhip effect is therefore, mainly impacting on operational, daily/weekly based performance, such as stock while, ripple effect has an impact up to strategical performances of the companies such as annual revenues.

To give a clear understanding of the concept, in his study (Yu and Goh, 2014), showed that most of the smaller suppliers to Japanese automotive and electronic original equipment manufacturer are single sourced. Therefore, in case of them being affected by disruption such as natural disasters, this will lead to the risk of having a repercussion on production that will lead to undesired delays on shipments and also a radical modification on production plans of downstream companies in the value chain. This study was validated by the real consequences of the Great East Japan Earthquake occurred in March 2011 in which most of the automotive companies of Japan had to stop for several weeks or months due to supply disruption with extreme consequences on annual financial performance. As provided by this cases, a little change in supplier down the value chain has the possibility to be passed through the subsequent tiers of the supply chain with the possibility of effects' amplification.

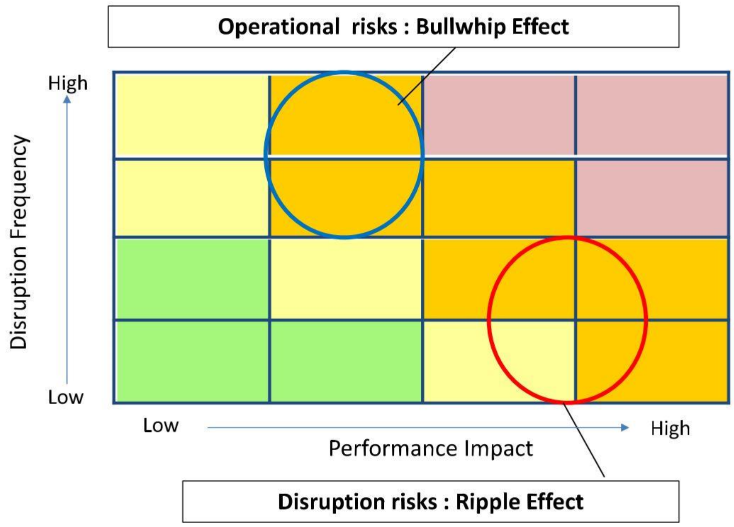

Figure 2.16: Bullwhip and Ripple effect (Dmitry Ivanov, 2017)

A structured definition of the ripple effect has been presented by (Ivanov et al., 2014) "*the ripple effect in the supply chain results from disruption propagation of an initial disruption towards other supply chain stages in the supply, production and distribution networks*". This concept is linked to the concept of recovery process or resilience practices that could mitigate the disruption and therefore reduce or avoid the rippling. Furthermore (D. Ivanov, 2017) stated from his simulation analysis that disruption propagation has an impact on the supply chain performance. On the other hand, resilience capabilities have positive impacts on both performances and prevention of disruptive propagation.

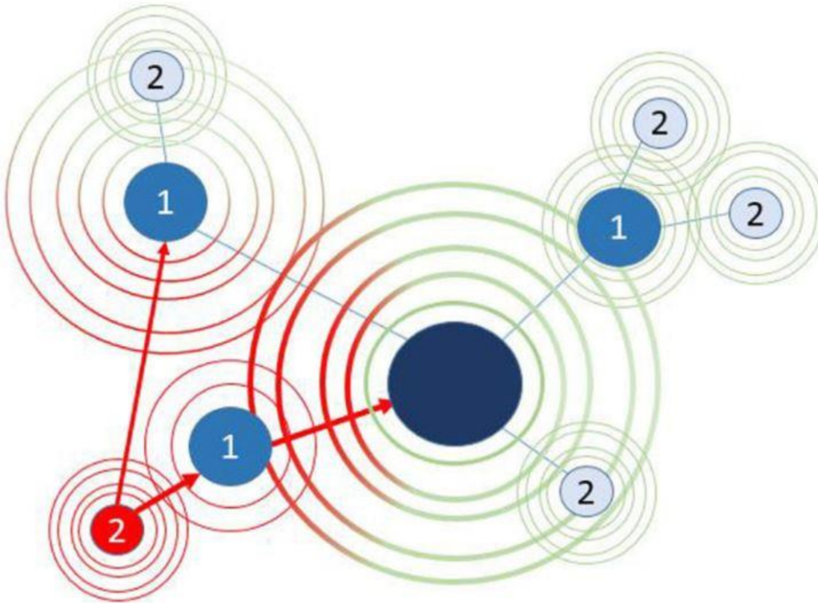

Figure 2.17: Disruption propagation in the Supply Chain (Dmitry Ivanov, 2017)

The concept of the ripple effect has also been addressed as the snowball effect (Świerczek, 2014). Like the ripple effect, the snowball effect has also been linked to the bullwhip effect. It addresses the propagation of a disruption, along the supply chain, as an amplification of its disruptive effects. In study of (Świerczek, 2014) proposed an investigation of the snowball effect in respect to forward and backwards flow of physical goods, information and finance. Focusing only on physical goods, the study hypothesizes two main drivers of the snowball effect. The intensity and the span of the supply chain referring to the first as a strong collaboration between the entities and to the second as the length of the ultimate supply chain.

2.3 Supply Chain Resilience (SCRES)

Supply Chain Resilience (SCRES) is a relatively new concept that has emerged from the broader concept of “resilience” that has been explored in a number of disciplines to which the broad notion of resilience is relevant. These disciplines basically included different perspectives and consideration such as, ecology, sociology, psychology, economics, organizational studies, and sustainable development (Ponomarov and Holcomb, 2009). Therefore, most of the academic scholars believe that resilience is a multidimensional and multidisciplinary concept with roots in psychology and ecosystems before being adapted to the supply chain management field (Bhamra et al., 2011, 2011; Datta et al., 2007; Pettit et al., 2013; Ponis and Koronis, 2012; Ponomarov and Holcomb, 2009). The disparate nature of the resilience literature – spread across many fields – and the broad notion of what the concept means has led to authors developing and using differing perspectives to describe the nature of SCRES(Tukamuhabwa Rwakira, 2015a). In order to discuss SCRES, it is better to mention to some the most important themes of enterprise resilience. First, the resilience is a dynamic capability of the organizations which focus on how well the enterprise embrace and respond to the disruptions. Second, the concept of resilience is not just an isolate characteristic of an enterprise, while a collaborative dependency mechanism among constitute of system (individuals, groups, and subsystems) is absolutely needed (Kamalahmadi and Parast, 2016a). According to statement of Dean Becker, the president and CEO of Adaptive Learning Systems, “More than education, more than experience, more than training, a person’s level of resilience will determine who succeeds and who fails” (Coutu, 2002). Third, management awareness and understanding of the environment and its pattern of changes which are the initial step towards the resilient organization. Fourth, the firm should capable in different aspect of the resilience such as surviving, adapting and responding and mitigating the negative effect of disturbances (Kamalahmadi and Parast, 2016a). In overall, the more development of certain organizational capabilities , the better capabilities of organization in order to mitigate the effects of disruptions (Pettit et al., 2013). Furthermore, firms must fully understand the environment and adapt to changes in order to ensure the survivability and business continuity. Afterwards, the firms should respond in an effective way to those disruption in a resilient perspective and taken into consideration two necessary aspect (Kamalahmadi and Mellat-Parast, 2016). The respond capability not only should reposition the firm to the previous status (stable status) but also, it should provide the pro-active, innovative and flexible measurements to prepare firm in terms of better anticipation, strengthen the market position in better responding to the future disruption (Lengnick-Hall et al., 2011). Therefore, the ability of the firm to better maintain its market position in a disruptive environment is depend on the progress of flexibles solutions and the ability of the firms to create novel measurements which are consistent with the changes and threatens on the environment (Kamalahmadi and Parast, 2016a). Moreover, an effective disruption mitigation should have high level of capability to create, design, and implement innovative solutions in a short period of time. As the concept of innovation is inherently based on the agility, the capability of the firms to actually implement an innovative solutions, is reflected level of preparedness of organization (Kamalahmadi and Mellat-Parast, 2016). Therefore, the development of SCRES is highly depend on development of enterprise resilience and innovative solutions during the disruptions. Based on the study of (Kamalahmadi and Mellat-Parast, 2016) which provided the Firm/Enterprise definition as " *the dynamic capability of an enterprise, which is highly dependent on its individuals, groups, and sub- systems, to face immediate and unexpected changes in the environment with proactive attitude and thought, and adapt and respond to these changes by developing flexible and innovative solutions".* The main characteristics such as (1) dynamicity; (2) dependency on individuals; (3) having knowledge of the environment; (4) survival, adaptation, and responsive capabilities; and (5) flexibility and innovativeness are covered by their definition. This understanding of SCRES from differing perspectives has led to lack of consensus on the definition of SCRES in the extant literature. Since the purpose of this research is to use the SCRES as a perspective and analytical lens, through the process of studying the state of the art on the topic, the scrutinized available definitions of SCRES is provided in table 2.6 according to the series of literature about SCRES, they emphasized on the capability to respond effectively to the disturbance and disruptions (Kamalahmadi and Parast, 2016a). In the definition of (Falasca, 2008) three factor are included as: probability of disruptions or disturbances, the consequences of disturbances, and response and recovery time. (Ponomarov and Holcomb, 2009) considered other critical factors in definition of SCRES, such as adaptive capability, unexpected events, response and recovery ability, and control over the structure. Regarding the proactive character of SCRES, (Ponis and Koronis, 2012) discussed planning and designing, anticipating unexpected events, responding adaptively, maintaining control over structure, and transcending to a post-event robust state of operation.

Table 2.6: SCRES definitions

Authors /Year	SCRES definition
(Rice and Caniato, 2003)	*"The ability to react to unexpected disruptions and restore normal supply network operations"*

(Christopher and Peck, 2004a)	*"The ability of a system to return to its original state or move to a new, more desirable state after being disturbed"*
(Closs and McGarrell, 2004)	*"The ability to withstand and recover from an incident and it is proactive - anticipating and establishing planned steps to prevent and respond to incidents. Such supply chains quickly rebuild or reestablish alternative means of operations when the subject of an incident"*
(Gaonkar and Nukala, 2007)	*"The ability to maintain, resume, and restore operations after a disruption"*
(Datta et al., 2007)	*"Not only the ability to maintain control over performance variability in the face of disturbance, but also a property of being adaptive and capable of sustained response to sudden and significant shifts in the environment in the form of uncertain demands"*
(Falasca, 2008)	*"The ability of a supply chain system to reduce the probabilities of disruptions, to reduce the consequences of those disruptions, and to reduce the time to recover normal performance"*
(Ponomarov and Holcomb, 2009)	*"The adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function"*
(Barroso et al., 2011)	*"The supply chain's ability to react to the negative effects caused by disturbances that occur at a given moment in order to maintain the supply chain's objectives"*
(Jüttner and Maklan, 2011)	*"The apparent ability of some supply chains to recover from inevitable risk events more effectively than others"*
(Cabral et al., 2012)	*"The ability to cope with unexpected disturbances. Supply chain resilience is concerned with the system ability to return*

	to its original state or to a new more desirable state, after experiencing a disturbance, and avoiding the occurrence of failures modes"
(Xiao et al., 2012)	*"The ability of returning to the original or ideal status when this supply chain system has been disturbed by external interruption, and resilient supply chain shows that this supply chain has the two abilities on adaptability to environment and recovering ability of the system"*
(Ponis and Koronis, 2012)	*"The ability to proactively plan and design a Supply Chain network for anticipating unexpected disruptive (negative) events, respond adaptively to disruptions while maintaining control over structure and function and transcending to a post event robust state of operations, if possible, more favorable than the one prior to the event, thus gaining competitive advantage"*
(Carvalho et al., 2012)	*"Resilience is referred to as the ability of supply chains to cope with unexpected disturbances"*
(Melnyk et al., 2014)	*"The ability of a supply chain to both resist disruptions and recover operational capability after disruptions occur"*
(Brandon-Jones et al., 2014)	*"The ability of a supply chain to return to normal operating performance, within an acceptable period of time, after being disturbed"*
(Roberta Pereira et al., 2014a)	*"The capability of supply chains to respond quickly to unexpected events so as to restore operations to the previous performance level or even to a new and better one"*
(Kim et al., 2015)	*"We define supply network resilience as a network-level attribute to withstand disruptions that may be triggered at the node or arc level."*

(Tukamuhabwa Rwakira, 2015a)	*"The adaptive capability of a supply chain to prepare for and/or respond to disruptions, to make a timely and cost-effective recovery, and therefore progress to a post-disruption state of operations - ideally, a better state than prior to the disruption"*
(Kamalahmadi and Parast, 2016a)	*"The adaptive capability of a supply chain to reduce the probability of facing sudden disturbances, resist the spread of disturbances by maintaining control over structures and functions, and recover and respond by immediate and effective reactive plans to transcend the disturbance and restore the supply chain to a robust state of operations"*

Based on the study of (Melnyk et al., 2014), two critical and complementary components of SCRES are defined as: (1) resistance capacity, which approach two sub categories in this field, avoidance: the ability of a system to minimize the impact of a disruption by evading it entirely and containment : minimizing the time between disruption onset and the start of recovery from that disruption. (2) Recovery capacity, the ability of a system to find a return path (recovery) to a steady state of functionality (stabilization) once a disruption has occurred. In a systematic literature review done by (Kamalahmadi and Mellat-Parast, 2016), the comprehensive definition of SCRES is provided as *"The adaptive capability of a supply chain to reduce the probability of facing sudden disturbances, resist the spread of disturbances by maintaining control over structures and functions, and recover and respond by immediate and effective reactive plans to transcend the disturbance and restore the supply chain to a robust state of operations"*. Several terms such as adaptability, flexibility, and agility are implicit in this definition and taken into account the three phases for SCRES, anticipation, resistance and recovery, and preparedness which explained later in this chapter. It can be argued that the two most comprehensive definition of SCRES are provided by (Ponis and Koronis, 2012)and (Ponomarov and Holcomb, 2009) which reflected and integrated multiple scientific disciplines. Their definition is included in general most characteristics such as adaptive capability and capacity, preparation, response and timely recovery to the original or, preferably, an improved level of operational performance (Tukamuhabwa

Rwakira, 2015a). Nevertheless, by considering the progress of SCRES definitions over the time, there is a slightly modified propositions among them through referring to previous ones or directly concluding from the theory building behind them (Hohenstein et al., 2015). While, those two earlier mentioned definitions (Ponis and Koronis, 2012; Ponomarov and Holcomb, 2009) are considered as comprehensive ones among the existing definition, the factor of cost-effectiveness is still ignored in their definition. Yet the World Economic Forum (2013) indicated that cost efficiency and resilience can coexist without a major negative impact and should ideally be complementary; therefor, hand (Tukamuhabwa Rwakira, 2015a) stated that the terms time and cost effectively are those factors, which make supply chain adaptive capable. Therefore, the cost efficiency is considered as feature of resilient system and the focus of SCRES is finally on reduction of costs through rapid and effective coordination among supply chain members. The term "adaptive capability" in definition of (Tukamuhabwa Rwakira, 2015a) reflects the nature of disruptive events, which recognized as unforeseeable and unpredictable, and enable the quick recovery of supply network and facilitated coordinated and self-organized responses for companies and its supply chain. In addition, the SCRES crates a competitive advantage through both abilities of risk management and responding to risk in a cost effective way (Hamel and Välikangas, 2003; Yao and Meurier, 2012). SCRES is not merely limited to the concept of readiness and reactiveness, but also the advantage of growing and improving the competitive position is considered (Hohenstein et al., 2015). Fundamentally, the two phases of response and recovery in definition SCRES are the main and widely mentioned regarding the reactive part of SCRES regarding the risk events. Therefore, those consideration of SCRES led to the insight that a universal SCRES has to include three different phases in order to comprehensibly acceptance (Hohenstein et al., 2015). The three different phases of SCRES are stated by (Kamalahmadi and Parast, 2016a) investigation illustrated in Figure 2.18.

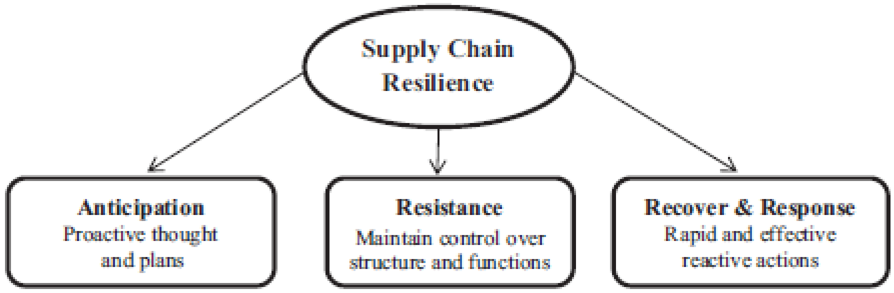

Figure 2.18 : Three phases of supply chain resilience (Kamalahmadi and Parast, 2016a)

1) Anticipation: The occurrence of disturbance and disruption events should be anticipated in such a way that made the organization and its supply chain prepared towards any expected and unexpected changes. Particularly, the impacts of those threaten should be totally analyzed and understood and their detrimental effect must be minimized. In emergency cases, the contingency plans should be prepared as well.
2) Resistance: After all preparation actions for anticipating the foreseen and unforeseen disturbance which detected in supply chain, the capability and ability of the supply chain to resist and deactivate the perturbation would play a key role.
3) Recovery and responses: Inherently, disturbances have the ability to detrimentally affect the SC and its performances. In this context, the immediate and effective responses extremely needed to reduce their negative impacts. Noticeably, the aim of well-prepared recovery and responses is not limited to reposition the firm to its pre-disruption status, but also to transcend the disturbance and potential threatening risks and provide the restoring firm's position to higher level and which can lead to have competitive advantages over competitors.

Since the main design of supply chains in general could be summarized in cost optimization and customer satisfaction, the traditional supply chains need to be redesigned to integrate resiliency into their design. Therefore, the reengineering of supply chains and designing based on resilience principles gain more attention than before (Ponomarov and Holcomb, 2009). With this consideration, (Christopher and Peck, 2004a) underlined the importance of the following factors for reengineering of supply chains: (1) supply chain understanding, (2) supply base strategy (risk awareness of suppliers), and (3) design principles for supply chain resilience based on strategies assessment of the trade-off between redundancy and efficiency. The two terms of practices flexibility and redundancy are widely discussed and used in literature associated with SCRES. Fundamentally, these two terms are relatively correlated to each other and there is an ambiguous in the level of emphasizing, allocation of limited resource of organization in order to develop flexibility and redundancy (Kamalahmadi and Parast, 2016a). While, there are numerous methodologies and techniques to evaluate the level of importance between the flexibility and redundancy, the discussion of flexibility vs. redundancy is still ongoing.

2.3.1 Supply chain collaboration

Nowadays, supply chains are extended across the globe due to the globalization increasing trend, which affects their risk of disruptions in whole supply chain. Therefore, the supply chain vulnerability is not restricted to the one zone or member of supply chain but even at network-level of vulnerability should be considered. Hence, the management of risk within a supply chain should be examined from a network perspective (Christopher and Peck, 2004a). The proper risk mitigation methodologies should be in corporate with high level of collaboration, cooperation, and partnership exists among the entities. In a simple word, collaboration act as the "glue that holds supply chain organizations in a crisis together. According to (Pettit et al., 2013), supply chain collaboration refers to the ability to work effectively with other entities for mutual benefit in areas such as forecasting, postponement and risk sharing. An empirical study by (Wieland and Wallenburg, 2013) on the influences of relational competencies such as communication cooperation and integration on SCRES showed that communicative and cooperative relationships have a positive effect on resilience, while integration does not have a significant effect. The study done by (Khanna and Bakshi, 2009) regarding the SCRES showed that having cooperative contracts among the supply chain partners influence on effective investment in SCRES and security through providing suitable responses. Further, it facilitated the sharing of sources and other complementary skills necessary from recovery of disruptions (Scholten and Schilder, 2015). Lastly, (Scholten and Schilder, 2015) illustrated the impact of certain type of collaboration activities such as information sharing, which lead to SCRES. In addition, collaboration could also involve information exchange, which can reduce uncertainty, increase transparency and facilitate the creation and sharing of knowledge, such as supply chain risks and uncertainties

(Christopher and Peck, 2004a). It enables the supply chain partners to share the cost of building security and resilience among each other (Khanna and Bakshi, 2009). Moreover, it influences the processes adopted by supply chain partners to ensure supply chain recovery (Ghadge et al., 2012). Two critical elements which play a key role in constructing an effective collaboration between the supply chain partners are (1) inter firm trust, and (2) Information sharing. The first psychological perspective which should be taken into consideration when the collaboration among the supply chain partners is going to initiate , depend on how much trust do members have to each other which lead to facilitate the cooperation in both organizational and across supply chain level (Faisal et al., 2007). Moreover, (Ponomarov and Holcomb, 2009) stated that, the greater degree of mutual trusting behaviors can cause greater relational resilience in buyer–supplier relationships and his results suggested that when the cooperation among the supply chain partners are considered in a longer relationship orientation, the mutual trusting is created among becomes more stronger. From network stand point, the problems and challenges are openly discussed and reach to better result, when different entities are collaborating in a trusted network environment which consequently enhance the resilience of supply chain (Kamalahmadi and Parast, 2016a). Secondly, Information sharing is another key priority and driver for developing both collaboration and resilience before and after the disruptions (Kamalahmadi and Parast, 2016a). From the collaboration point of view, it facilities the creation of a supply chain community where there is exchange of information among members of the supply chain (Christopher and Peck, 2004a). When there is an effective and efficient information exchange among the supply chain members, the collaboration would properly happen in this condition. In according to the result gained by (Soni et al., 2014), the improvement of system ability to deal with possible future disruptions during all three phases of disturbance occurrence : before, throughout and after is strengthen through post disruption collaboration and information sharing.

2.3.2 Visibility

(Francis, 2008) defined visibility as "the identity, location and status of entities transiting the supply chain, captured in timely messages about events, along with the planned and actual dates/times of these events" (Francis, 2008). In a simple word, visibility refer to the ability of seeing one end of the pipeline, from the other end (Christopher and Peck, 2004a).

In more conceptually, visibility is defined as the knowledge of operating status of assets and environment (Pettit et al., 2013), thereby also helping to avoid overreactions, unnecessary interventions and ineffective decisions in circumstances of risk (Christopher and Peck, 2004a). In the first perspective the visibility is assumed as one of the drivers of agility. Based on (Wieland and Wallenburg, 2013), visibility is a prerequisite for response and enables executives to better understand about the possible changes. According to (Wieland and Wallenburg, 2013) visibility enables managers to know about the changes; thus, it is a prerequisite for response. They hypothesized and further verified that communication and cooperation will improve agility and resilience by enhancing visibility of functions and operations. For example, Procter & Gamble planners have tried to strengthen their supply chain visibility by installing monitoring tools to map the supply chain so as to improve threat awareness and receive timely warnings of potential disruptions (Sáenz and Revilla, 2014). In the second perspective, the visibility is assumed to be one of driver of resilience while it is considered separately from the agility (Blackhurst et al., 2005; Carvalho et al., 2012; Jüttner and Maklan, 2011; Ponis and Koronis, 2012; Soni et al., 2014). The empirical study conducted by (Blackhurst et al., 2005) in order to understand what and how properly mitigate the effect of disruptions , depicted that visibility as an important elements in disruption discovery phase and a key factor for mitigating the disturbance effects. In addition, sharing the risk and knowledge in supply chain could increase the SCRES through enhancing the supply network visibility (Jüttner and Maklan, 2011). (Sáenz and Revilla, 2014) further describe how supply chain visibility helped Cisco to improve its agility and resilience to the Japanese earthquake and tsunami of 2011. Within twelve hours of the disaster, Cisco was able to map out its supply base beyond tier one suppliers (more than 300 suppliers) and within twenty-four hours, it was able to trace its customers and field 118 customer enquiries (Tukamuhabwa Rwakira, 2015a).

2.3.3 Velocity

While the concept of speed is inherited to agility, in order to incorporate the speed and time in to the agility, the concept of velocity, which considered as one of the building block of agility, has been introduced as facilitator in this context. Basically, velocity means distance over time (Christopher and Peck, 2004a). From risk perspective, velocity determines the losses that happens per unit of time which means the recovery speed of the supply chain risk events (Jüttner and Maklan, 2011). Furthermore, where the pace of flexible adaptation under the disruptive events is becoming more concerned, the relevance of velocity with flexibility and adaptability is become critical. Therefore, some authors mentioned the concept of velocity in their flexibility definition (Joseph Fiksel, 2014; Soni et al., 2014). The velocity has a positive impact on the enterprise revenue targets and it is considerably supported the flexibility through adding the proper pace to the supply chain adaptability (Jüttner and Maklan, 2011). The study done by (Smit, 2005b) mentioned three different forms of velocity in general. First, the rate at which risk happen. Second, that rate at which the losses occurred and third, how quickly the risk event is recovered. Velocity is closely related to flexibility and adaptability, where it is concerned with the pace of flexible adaptations (Stevenson and Spring, 2007). Based on this relationship, some authors considered velocity in their flexibility definitions (Joseph Fiksel, 2014; Soni et al., 2014). The three basic pillar of improvement of supply chain velocity are suggested by (Christopher and Peck, 2004a) as: (1) implementing the streamline processes, which means doing in parallel rather than in series (2) eliminating non value- added activities and consequently minimizing the time for them and (3) reduction in bound lead times, which means being able to respond rapidly, and cope with short term changes.

CHAPTER 3

THEORETICAL FRAMEWORK

Chapter 3 presents the research framework and question adopted in the study. First, the research framework is delineated, and the main constructs and relationships between them are introduced. Secondly, the key constructs of BCM and SCRES are briefly defined. Then, literature providing evidence and insights on the link between BCM and SCRES constitutes and the relationships among them is illustrated through a theoretical matrix according to extant literature. Finally, the theoretical models and relevant hypotheses (HPs) are provided.

3.1 Research framework

Based on the previous section that provided the more conceptual elements and constructs of BCM and SCRES, the final framework of this thesis is design and shown in Figure 3.1

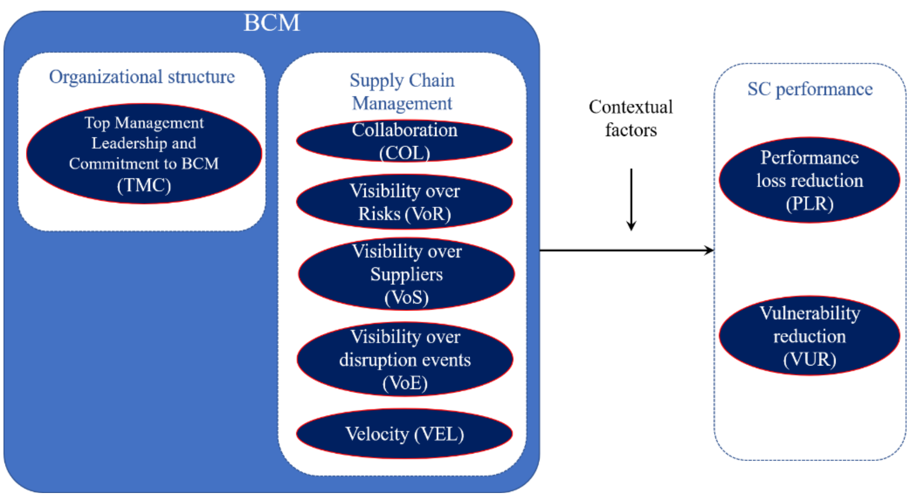

Figure 3.1: Research framework

BCM is evaluated according to both organizational structure that included Top Management Leadership and Commitment to BCM (TMC) and supply chain management, with main focus on resilience aspect that included: Collaboration (COL), Velocity (VEL), Visibility over Risks (VOR), Visibility over Suppliers (VoS), Visibility over disruption Events (VoE) and Velocity (VEL). The target variable includes: Performance Loss Reduction (PLR) and Vulnerability Reduction (VUR) which finally are analyzed to reduce their detrimental effect. In addition to those variables, the contextual variables such as Insurance coverage (INS), Company size (SIZE) and Industry Sector (SEC) are worth to considering since they played moderating effect on the target variables. Finally, as the Figure 3.1 Illustrates the contribution of BCM concept on SC performance under the disruption effect of focal company is depicted by the arrow between two aforementioned factors with consideration of contextual variables and the and the research question is provided as:

- RQ: How does BCM influence the focal company's performance in face of supply chain disruptions?

In order to better understand the influence of BCM on SC performance and vulnerability, two separated models and relevant hypotheses are created. Firstly, the model related contribution of BCM to SC performance under disruption is evaluated and its relevant HPs are proposed based on the Figure 3.2.

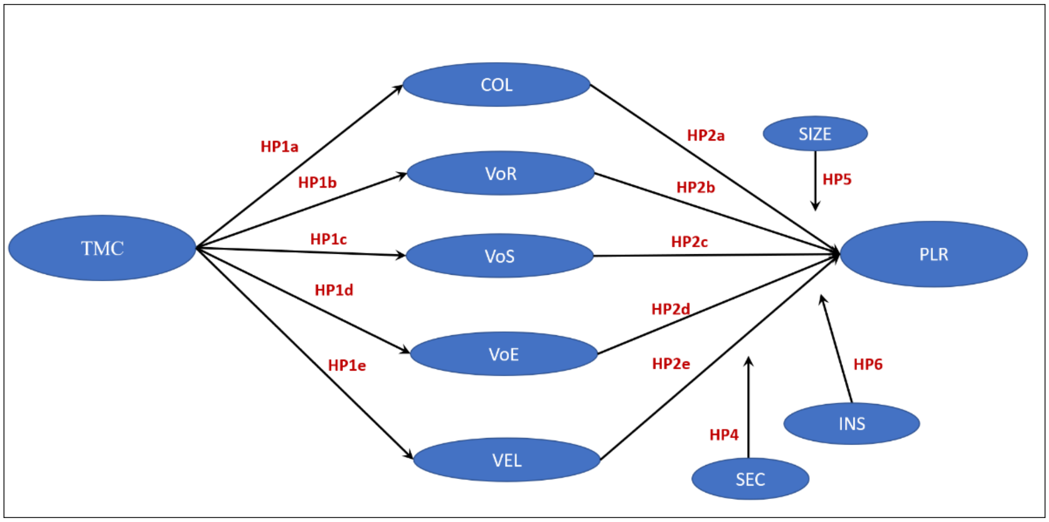

Figure 3.2: Theoretical framework for model 1

Generally, the BCM policy is set by senior management, taking into account the goals, obligations and the purpose of the firm towards continuous improvement (Aleksandrova et al., 2018). The first step in order to implement the BCM is the executive commitment and continuous support is paramount to ensure business continuity is effectively integrated in key processes (Wong, 2019) and as mentioned in previous chapter, the leadership and culture is one the most critical step of ISO and PDCA. In this context the relationship among TMC to BCM and the supply chain resilience management is considered since the effect of TMC is the key part of BCM for implementation, the contribution of the executive as decision maker is consider as the positive effect on the SCRES components and broadly discussed (Germain et al., 2012; ISO 22301, 2012; Kato and Charoenrat, 2018a; Smit, 2005b). Managers should also seek to connect processes and to develop in collaboration with supply chain partners practices such as business continuity analysis or security procedures (Revilla and Jesus Saenz, 2017) . The first hypothesis and its sub-hypotheses are proposed as follows:

- HP1: Top Management leadership and commitment to BCM (TMC) has positive effect on supply chain resilience management.
    - HP1a: Top Management leadership and commitment to BCM (TMC) has positive effect on collaboration (COL).
    - HP1b: Top Management leadership and commitment to BCM (TMC) has positive effect on visibility over risk (VoR).
    - HP1c: Top Management leadership and commitment to BCM (TMC) has positive effect on visibility over supplier (VoS).
    - HP1d: Top Management leadership and commitment to BCM (TMC) has positive effect on visibility over events (VoE).
    - HP1e: Top Management leadership and commitment to BCM (TMC) has positive effect on velocity (VEL).

According to the comprehensive nature of BCM which not only focus on the protection of the firms before the disruptive events but also provide the recovery capability during and after the crisis which absolutely needed the high level of collaboration of firm with other supply player which lead to minimize the effect of negative impact of detrimental and risky events towards supply chain. Based on the two elements of BCM as, BIA and risk assessment, the implementation and the continuity of the organization is kept according the result of BIA with visible risk assessment plan and strategy (Torabi et al., 2014). Consequently, the BCM equips the enterprise in sense of cooperating better with their suppliers and evaluate the suppliers in terms of BCM implementation and SCRES that boost the VoS. In this context, the BCM also enhance the inherent capability to improve the aspect of resilience for organization to identify and monitor events and respond them accurately (i.e. resourcefulness (Rezaei Soufi et al., 2019). Additionally, the integrated BCM, enabled the organization in considering most of risk causes and assessment of their detrimental effect on performance through BIA that contributed to gain velocity in SC level (Jüttner and Maklan, 2011). In other words, BCM helped the firms when the disasters happened to overcome with their negative effect and considerably reduce the PLR in area of SCRES. Ultimately the contribution of BCM to the supply chain performance loss through the boosting the SCRES elements is analyzed and the HPs are stated as follows:

- HP 2: BCM implementation positively contributes to supply chain performance loss reduction by enhancing Supply Chain Resilience constituents.
    - HP2a: BCM implementation enhances Collaboration (COL) which has positive effect on supply chain performance loss reduction (PLR).
    - HP2b: BCM implementation enhances Visibility over risk (VoR) which has positive effect on supply chain performance loss reduction (PLR).
    - HP2c: BCM implementation enhances Visibility over suppliers (VoS) which has positive effect on supply chain performance loss reduction (PLR).
    - HP2d: BCM implementation enhances Visibility over events (VoE) which has positive effect on supply chain performance loss reduction (PLR).
    - HP2e: BCM implementation enhances Velocity (VEL) which has positive effect on supply chain performance loss reduction (PLR).

In addition, the model 1 is taken into consideration the contextual variables on the performance of SC. Firstly, the role of the industry sector evaluated in terms of the moderating effect on supply chain performance. In this context, the six different categories on industry sector such as: Manufacturing, Utility, Retail and warehouse, Financial, Public administration and Other are analyzed in order to figure out that based on the BCI resilience report , being in a certain sector could change and modify the relationship among the SCRES and PLR. Following this consideration, the fourth HP is stated as follows:

- HP 4: Industry sector (SEC) has positive moderating effect on supply chain performance loss reduction (PLR).

The company size in this survey composed by number of enterprise employee ([From 0-250] … [>100,000]) and annual revenue that ranged [From 1-10 M€] … [>50 B€]. In this regard, the moderating effect of SIZE is investigating to find out if there is contribution among the SIZE of the firms and level of supply chain performance under the disruptions. Based on those consideration, the fifth HP is provided as follows:

- HP 5: Company size (SIZE) has positive moderating effect on supply chain performance loss reduction (PLR).

One of the main measures in order to reduce the exposure to the negative financial effect of SC disruption apart from available tools such as implementation of strict safety and quality standards, is the Insurance Coverage (INS) towards SC risk and continuity management. Commercial insurance means insurance of companies such as producers, distributors, shippers, trading companies and wholesale and others. Commercial insurance covers insurable risks of entrepreneurial activities, whether a property or a commercial liability insurance and focus on four key areas: protection of employees, protection against liability to the third parties, protection of assets and protection against downtime (Njegomir and Demko-Rihter, 2015). The INS is a critical element of success in BCM and continuity of operations and if the companies are not in that position to finance their losses after an accident that cause interruption in SC, they certainly will fail. Likewise, the INS cannot directly safeguard companies from accidents and subsequent disruptions but is the most important source of indemnification for losses when insured events materialize (Njegomir and Demko-Rihter, 2015). Despite the positive effect of SCRES constituents on PLR, the INS positively affect the PLR and this effect is stated as below:

- HP6: Insurance coverage (INS) has positive moderating effect on supply chain performance loss reduction (PLR).

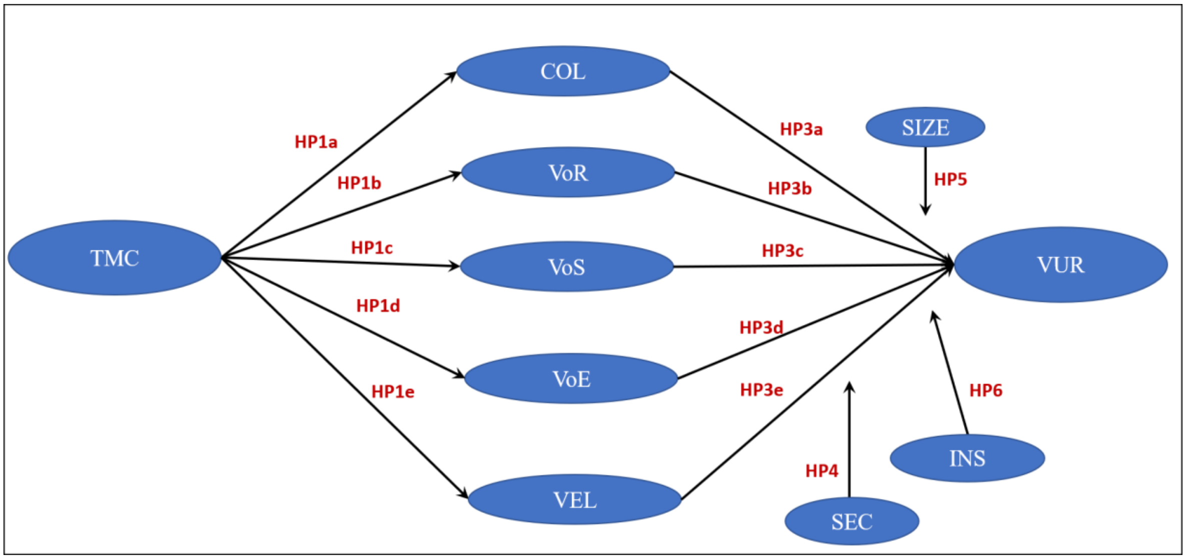

Figure 3.3: Theoretical framework for model 2

In the model 2, the contribution of the BCM on vulnerability reduction (VUR) of the SC is evaluated base on the theoretical framework illustrated in Figure 3.3. Similar to previous theoretical framework the role of TMS in BCM implementation and its effect on SCRES elements is considered through the first HP.

- HP1: Top Management leadership and commitment to BCM (TMC) has positive effect on supply chain resilience management.
    - HP1a: Top Management leadership and commitment to BCM (TMC) has positive effect on collaboration (COL).
    - HP1b: Top Management leadership and commitment to BCM (TMC) has positive effect on visibility over risk (VoR).
    - HP1c: Top Management leadership and commitment to BCM (TMC) has positive effect on visibility over supplier (VoS).
    - HP1d: Top Management leadership and commitment to BCM (TMC) has positive effect on visibility over events (VoE).
    - HP1e: Top Management leadership and commitment to BCM (TMC) has positive effect on velocity (VEL).

Apart from the positive effect of BCM implementation on PLR, the contribution of BCM in vulnerability reduction is another aspect which worth investigating in area of SCRES. Based on today's global SC that vulnerable to different risk and hazards which drastically lead to loss in productivity, competitive advantage and profitability, BCM play a key role in reducing the those effect. According to the allocated two questions to vulnerability as a number of incidents that the firms experienced during a year and the level of severity that the SC has been affected, the implementation of BCM will affect positively in reduction of vulnerability. The BCM enhance the collaboration such as exchange sensitive information and transparency, through evaluation whether or not the suppliers apply and use the BCM when they faced with disruptive events. As mentioned before, the implementation of BCM enhance the capability of the SC visibility. More specifically and based on the three different types of visibility that defined in this survey, the BCM form a comprehensive plan which facilitate the firms to handle the SC vulnerability and manage various both internal and external detrimental events which ultimately lead to VoR and VoE. According to provided argument, the collaboration among SC players make a clear overview of BCM implementation, and considerably reducing the inefficiency through establishing the VoS. Although, the disaster events are indispensable part of the global and focal SC and each firms is faced with SC incidents with different level of severity, the BCM prepare the capacity for enterprise to survive, adapt and grow in face of turbulent events. Therefore, the VEL of firms will enhance through the improvement of BCM. In addition, the focus of BCM system in supply chain performance is to represent the direct and indirect effect to mitigation strategy, here the main point is utilizing the SCRES elements as a theoretical and analytical perspective, that minimize the detrimental effect of threats. According to the provided argument around the positive effect of BCM on VUR, the relevant HP and sub-HPs are proposed in below:

- HP3: BCM implementation positively contributes to supply chain vulnerability reduction by enhancing Supply Chain Resilience constituents.
    - HP3a: BCM implementation enhances Collaboration (COL) which has positive effect on supply chain vulnerability reduction (VUR).
    - HP3b: BCM implementation enhances Visibility over risk (VoR) which has positive effect on supply chain vulnerability reduction (VUR).

- HP3c: BCM implementation enhances Visibility over suppliers (VoS) which has positive effect on supply chain vulnerability reduction (VUR).
- HP3d: BCM implementation enhances Visibility over events (VoE) which has positive effect on supply chain vulnerability reduction (VUR).
- HP3e: BCM implementation enhances Velocity (VEL) which has positive effect on supply chain vulnerability reduction (VUR).

In addition, the model 2 takes into consideration the contextual variables on reduction of SC vulnerability. Firstly, the role of the industry sector evaluated in terms of the moderating effect on VUR. In this context, the six different categories on industry sector such as: Manufacturing, Utility, Retail and warehouse, Financial, Public administration and Other are analyzed in order to figure out that based on the BCI resilience report, being in a certain sector could change and modify the relationship among the SCRES and VUR. According to the constructs of VUR in this survey, the moderating effect of SEC is evaluated to figure out how this contextual variable could lead to reduction of vulnerability. Following this consideration, the HP is stated as follows:

- HP 4: Industry sector (SEC) has positive moderating effect on vulnerability reduction (VUR).

The company size in this survey composed by number of enterprise employee ([From 0-250] … [>100,000]) and annual revenue that ranged [From 1-10 M€] … [>50 B€]. In this regard, the moderating effect of SIZE is investigating to find out if there is contribution among the SIZE of the firms and level of supply chain vulnerability. Based on those consideration, the fifth HP is provided as follows:

- HP 5: Company size (SIZE) has positive moderating effect on supply chain vulnerability reduction (VUR).

One of the main measures in order to reduce the exposure to the negative financial effect of SC disruption apart from available tools such as implementation of strict safety and quality standards, is the Insurance Coverage (INS) towards SC risk and continuity management. Commercial insurance means insurance of companies such as producers, distributors, shippers, trading companies and wholesale and others. Commercial insurance covers insurable risks of entrepreneurial activities, whether a property or a commercial liability insurance and focus on four key areas: protection of employees, protection against liability to the third parties, protection of assets and protection against downtime (Njegomir and Demko-Rihter, 2015). The INS is a critical element of success in BCM and continuity of operations and if the companies are not in that position to finance their losses after an accident that cause interruption in SC, they certainly will fail. Likewise, the INS cannot directly safeguard companies from accidents and subsequent disruptions but is the most important source of indemnification for losses when insured events materialize (Njegomir and Demko-Rihter, 2015). Despite the positive effect of SCRES constituents on VUR, the INS positively affect the VUR through reduce the level of damaged effect by proper financial coverage and this effect is stated as below:

- HP6: Insurance coverage (INS) has positive moderating effect on supply chain vulnerability reduction (VUR).

3.2 Research constructs

As emerged from the literature review in Chapter 2, there is lack of studies have deeply investigated the influence of BCM on focal company SC performance of focal company under the disruptions. While, there are some investigations which focus merely on BCM and its constructions in a theoretical and analytical way (Bajgoric, 2014b; Herbane et al., 2004b; Junttila, 2014; Kato and Charoenrat, 2018b; Montshiwa et al., 2015; Randeree et al., 2012b; Röglinger et al., 2012; Smit, 2005b; Tammineedi, 2010) and on the other side, there are some investigations which analyse the SCRES and its constructions, under the disruptive events (Christopher and Peck, 2004b; Hohenstein et al., 2015; Kamalahmadi and Mellat-Parast, 2016; Kamalahmadi and Parast, 2016b; Pettit et al., 2013; Roberta Pereira et al., 2014b; Zhang and Wang, 2011) there is still room for analysing the BCM contribution and effect on SC performance. Therefore, this research seeks to contribute in further analysing this relationship, considering link between BCM and SC performance of focal company through using the SCRES as a theoretical lens. With this consideration, two main concepts, BCM and SCRES constitutes are deeply defined below. Due to the main focus of the research in BCM and its effect on Sc performance, in below, first the BCM constructs are analysed.

- Top management leadership and commitment to BCM (TMC): It is essential that business continuity program to be initiated, sponsored and authorized by senior management from the preliminary phase of its implementation. The management and leadership commitment is assumed as one of the primary factor in ensuring business functions and services operating at an acceptable condition under crisis situation and managing an organization's risk exposure to service disruptions are crucial elements of the overall corporate strategy (Bakar et al., 2015b). In the context of BCM, it is a long-term commitment that necessitates a substantial financial investment by an organization. Hence, only strong engagement by the senior management can warrant the on-going provision of monetary support and other critical resources for developing and maintaining a BCM program (Bakar et al., 2015b). On the contrary, the lack of senior management commitment will ultimately result in poor executions, lack of corporate wide involvement and at the end, program failures. In a similar manner, a lack of senior management understanding also hinders the effectiveness of a BCM program implementation. Finally, without the sponsorship and visionary leadership from the management, most initiatives will not be effective and lesser chance for innovation and mobilization of potencies for organizational transformation (Bakar et al., 2015b).
- Business Impact Analysis (BIA) and Risk Assessment: BIA is an important process that probes into business processes to determine and list critical processes that are vital to keep the business going and provides several benefits to the organizations in terms of identifying the disruptions and evaluating their effects. It is necessary to understand business environments, gather data and information, identify critical processes needed to carry out vital business operations and finally prepare a BIA report enlisting your findings to be submitted to the top management (Sikdar, 2011). BIA covers three main goals such as identification of critical processes which once stopped, will strongly affect the delivery of critical products and services of firms, identification of both financial , non-financial and operational impact that a disruptive

events could cause to the firms performance and the prioritization of the critical processes, which means the order in which these processes should be recovered after an outage. In addition, the BIA should specify the minimum level of resources needed to keep the processes working and internal/external dependencies. The business-impact analysis phase helps the organization to understand, identify and classify its business systems, processes and external stakeholders based on their significance to the business, and through this, determine risk mitigation and recovery strategies (Segovia, 2017). The BIA is a very important analysis which should be done very carefully. It is the input for other analysis as Risk Assessment and the Business Strategies (Dominguez, 2016). The risk assessment is considered as an activity that enables an organization to priorities and plan the recovery and mitigation strategies for its BCM program based on business priorities (Segovia, 2017). The main purpose of risk assessment is the identification and the assessment of all the threats that could affect the critical elements of the BCMS. This step is included the identification of threats, evaluation of the likelihood and impact of these threats, application of countermeasure to avoid, handle or mitigate the risks, and finally actions in order to monitor and review that the controls are in place and the protected assets are safe. Furthermore, identification and categorization of different hazards that could affect the organization and firms through methodologies such as HAZOP Hazard and Operability Study) and FMEA (Failure Mode and effects analysis) (Dominguez, 2016). Both the risk analysis and BIA components enable an organization to address business continuity holistically across the organization.

- Business Continuity Plan (BCP): There is a clear dependency between BCP and BCM literature and historically, BCP preceded BCM. BCP is a system that has been developed primarily by practitioners to minimize the effects of unanticipated events on the firm's ability to meet customer requirements. Planning and managing disruptions is now an expected part of managing supply chains. Responding to these potential disruptions can take many forms: actions aimed at reducing the probability of a disruption taking place; measures aimed at reducing the impact of the disruption once it occurs, and some combination of these two tactics. Therefore, BCP consider vital issues to be observed by organizations and firms due to providing an ensures that personnel and assets are protected when faced with disruptive events and capable to do their functions quickly (Zsidisin et al., 2005). Reliability and risk assessment methodologies compose powerful tools to support BCP with them it is possible to identify potential threats to an organization and their associated impacts to business operations, and to provide a framework for building organizational capability for an effective response that safeguards the interests of its key stakeholders, reputation, brand and value creating activities.

- Business and IT alignment: Based on the business functions being performed and their reliance on the technological advancement such as IT and the extent that level of dependency is determined. While some portion of critical business processes can be recovered and return to their stable status without IT or information, in other cases, IT systems and information are needed to support the recovery of some critical business processes. Basically, firms determine the maximum downtime of IT systems that can occur before it becomes an issue that could jeopardize the entire organization, whether it be hours, days, weeks, or more (Järveläinen, 2013). Generally speaking, disaster recovery planning is a common term used to describe IT recovery while some companies use different terms to include the recovery of IT systems, data, information management systems and processes, and other related systems (Järveläinen, 2013).
- Performance evaluation: The importance of this phase lies in the fact that without measurement it is impossible to know how the system is working or even if it is working or not. Due to this fact, this phase proposes to “check” or to evaluate the actual BCM systems. According to the necessities of every organization different factors of the BCMS can be assessed. In order to do this, the organization should establish their measurement process and the implementation of internal audits and management reviews (Dominguez, 2016). To guarantee continuity of the different services it is important that the organization establishes performance indicators, which include the management and the technical side. In the case of the technical metrics, the organization should previously evaluate their technological platform. Based on this, the measures for reliability, availability, and scalability should be indicated. The audit process should be performed by an independent entity (Dominguez, 2016). If the organization does not have an audit department it can be performed by a third party. Therefore, this phase will allow the firms to evaluate their BCM and perform follow ups. Furthermore, the metrics and measures established in

the performance assessment of BCM allow the organization to perform the necessary changes in the BCM system (scope, plans, and improvements in processes or performance indicators, among others). These reviews let the BCM system be updated because it keeps them in contact with the external enablers as new regulations appear or new risks arise. Furthermore, these reviews help to perform follow-ups of the nonconformities found during the audits (Dominguez, 2016).

As discussed in chapter 2, SCRES is the "adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function" (Ponomarov and Holcomb, 2009). The constituents of SCRES, formative elements, are i.e. flexibility, velocity, visibility and collaboration (Jüttner and Maklan, 2011) which defined as follows:

- Flexibility is defined as the ability of an enterprise to adapt to the changing requirements of its environment and stakeholders with minimum time and effort (Tukamuhabwa Rwakira, 2015a). It represents the easiness with which a supply chain can change its range number (i.e. number of possible options) and range heterogeneity (i.e. degree of difference between options), to cope with a range of market changes and events while performing comparably well. In some cases, it is identified with redundancy, i.e. the duplication of capacity so that operations can continue following failure (Johnson et al., 2013) (Jüttner and Maklan, 2011).
- Velocity is the speed with which a supply chain can react to and recover from market changes (Jüttner and Maklan, 2011).
- Visibility is defined as the ability to see through the entire supply chain (Tukamuhabwa Rwakira, 2015a), helping in detecting signals and having knowledge of the status of a supply chain's assets and environment. It is the extent to which actors within the supply chain have access to or timely share information about identity, location and status of entities within the network, as well as events and their planned and actual dates and times (e.g. events regarding end-to-end orders, inventory, transportation and distribution, but also environment) (Jüttner and Maklan, 2011).

- Collaboration is the ability to work effectively with other entities for mutual benefit in areas such as forecasting, postponement and risk sharing (Tukamuhabwa Rwakira, 2015a). It represents the level of joint decision making and working together at a tactical, operational or strategic level between two or more supply chain members. It is scalable through the magnitude of relationship strength, quality and closeness. Since collaboration could involve information exchange, which can reduce uncertainty, increase transparency and facilitate the creation and sharing of knowledge, it is strictly related to visibility. Moreover, due to the consequent alignment of forces in case of disruption, it can have a positive effect on flexibility, allowing companies to minimise the effort to adapt. Therefore, in the study it is important to consider it only when risk sharing, reciprocal contribution and coordination are present, distinguishing it from the other resilience constituents.

Finally, by considering all the BCM and SCRES and the reviewing the literature in chapter 2, the matrix of those two elements are created to show the relationship among each of the constituents.

Table 3.1: Mapping BCM vs SCRES constituents

SCRES \ BCM	Executive Management Commitment	Business Impact Analysis &Risk Assessment	Business Continuity Plan	Business & IT Alignment	Performance Evaluation
Collaboration		x	x	x	x
Visibility		x	x		x
Velocity		x	x	x	
Flexibility		x	x	x	x
Leadership and culture	x		x		
Vulnerability		x			x
Sc performance		x			x

Ideally, the Table 3.1 illustrates all the potential relationships and relevance which could be related to both SCRES and BCM. Furthermore, since the target variable of this study is included two concepts, Vulnerability and SC performance, those variables also added to the matrix and their contribution to the BCM elements is evaluated. In the study done by… the effect of collaboration and visibility in the supplier's recovery capability was analysed and underlined the fact that, improvement of them will positively affect the performance evaluation and BCP for both suppliers and buyers in face of disruptions (Namdar et al., 2018). As mentioned before, one aspect of collaboration is related to level of information sharing among the players in SC, therefore Business and IT alignment could be affect in how firm's cooperation is proper and efficient. Furthermore, visibility and collaboration strategies enhancing the buyer-supplier relationships and risk exposure, reducing the recovery time after the disruptions and enabling the advance BIA and risk assessment (Namdar et al., 2018). In addition, different measurable constructs of SC visibility are imposed to drive the SC configurability and improve the SC performance and evaluation. Based on the velocity definition provided by Christopher "speed of motion, action, or operation, rapidity and swiftness" and according to risk perspective, it determines the loss that happens per unit of time the concept of BIA and risk assessment is obviously relevant. On the contrary to the flexibility that emphasized on the level of robustness and reconfiguration of SC state, velocity focuses on pace of flexibility. According to the four different forms of velocity such as , the rate at which a risk events happens, the rate at which losses happens, how quickly the disruptive and risk events discovered and the speed which the SC can recover from those events facilitated by IT technologies and BCP proper implementation (Jüttner and Maklan, 2011). Since flexibility in SC ensures that changes caused by the risk event can be properly absorbed by the SC through effective responses, resolve and, when appropriate exploit unexpected emergencies. Furthermore, the flexibility can support the sensing disruption and improve the level of readiness (Jüttner and Maklan, 2011). Therefore, the relationship between flexibility and BCP, BIA and risk assessment could be created in the field of BCM and the result of being flexible SC in terms of deal with disruptions contribute to better performance evaluation of SC and the more the to some extent the level of flexibility related to the level of Business and IT alignment due to the role of facilitation and improvement of IT technologies in terms of SC functions (Jüttner and Maklan, 2011). As mentioned before, the role of top management commitment to both BCM and SCRES plays a significant role in order to initiate such a comprehensive plan. From the organizational standpoint, this culture paved the way for the firms in order to implement a continuous program towards the disruptive events in their SCs. As a result, the executive commitment to both BCM and SCRES would be gain the importance and related to each other and positively affect BCP implementation as well. Vulnerability is an exogenous variable that determines the risk through the intensity of the impact generated or caused damage 10. According to (Bonnefous et al, 1997), "Vulnerability is the status or the degree of fragility of a system." According to (CRAIM, 2007), "Vulnerability is the readiness with risk" in this context, vulnerability is characterized by the capacity of the system and its preparation to face the hazard or anticipated consequences. (Pettit et al., 2013) defines it as "The potential for a system to be affected by internal and / or external hazards (Elleuch et al., 2016). Vulnerability in the supply chain is a concept that fall within the area of risk management and ensuring the performance of the SC and it has essentially dealt with the ability to know what to expect 10. Therefore, there is a close relationship between the vulnerability and BIA and risk assessment in area of BCM (Elleuch et al., 2016).

3.3 The BCI supply chain resilience dataset and report (2017)

The dataset used in this study has been created by the Business Continuity Institute (BCI) by administering a questionnaire to SCM and BCM managers to publish the “BCI supply chain resilience report 2017” which is one of the earliest and most comprehensive studies focusing on origins, causes and consequences of supply chain disruptions worldwide. The BCI survey captures different aspects of supply chain management and BCM, ranging from what threats companies’ operations to how they prepare for them. Given the international scale of this report, as supply chains usually involve operations in several countries, it is worth mentioning that the 408 respondents which came from 64 different countries. This is key to understanding how similar threats might affect operations in different geographical regions. The survey contains 28 questions provided by excel sheet form and each respond answer them based on the different style from “Yes, No”, different ranging multiple choices and Likert scale. The industry sector considered in the survey is six categories such as: Manufacturing, Utility, Retail and warehouse, Financial, Public administration and Others). Furthermore, the company size which took part in BCI survey is measured by two factors such as: Number of employees ranged [From 0-250] … [>100,000] and Annual revenue ranged [From 1-10 M€] … [>50 B€]. Among total number of 28 questions, 17 of them selected and used for this thesis. In Table 3.2 the number of questions allocated to each SCRES elements (and their corresponding relationship with BCM elements). According to the nature and the meaning of SCRES and due to use of already design BCI report questionnaire, this study considers just four SCRES constituents as, collaboration, visibility, velocity and leadership & culture.

Table 3.2: Number of questions allocated to BCM and SCRES constituents

SCRES \ BCM	Executive Management Commitment	Business Impact Analysis &Risk Assessment	Business Continuity Plan	Business & IT Alignment	Performance Evaluation	N questions
Collaboration			2		2	4
Visibility		2	2		2	6
Velocity		1				1
Leadership and culture	1		1			2
Vulnerability		2				2
Sc performance		2				2
						17

In detail, different questions have been used to operationalize our constructs, as reported in the following.

- SC performance losses under disruptions (dependent variable):
    - Which of the following impacts or consequences arose from the incidents/disruptions experienced in the last 12 months? Tick as many as applicable.
    - What was the approximate financial cost of your cumulative, as well as the most significant, supply chain incident in the last 12 months (loss of revenue and/or increased cost of working)? Please give your response in euros. Exchange rate (March 2017): 1 USD = 0.94 EUR = 0.82 GBP = 1.32 AUD = 1.35 CAD.

- SC vulnerability (dependent variable):

    - How many supply chain incidents would you estimate your organization experienced in the past 12 months that caused a significant disruption?
    - How severely has your supply chain been affected by any of the following sources of disruption over the past 12 months? (Severity levels can be considered in terms of initial impact, ability to continue to deliver key products and services, and recovery time, as well as the consequences on brand and reputation.)
- Visibility:
    - Visibility over risk:
        - Do you use technology (e.g. risk analytics indicators) to analyze, track or monitor potential performance-affecting supply chain issues that could cause disruptions?
        - What types of solutions do you rely on to analyze, track or monitor potential issues causing supply chain disruptions? (Please indicate all that apply)
    - Visibility over suppliers
        - Considering your key suppliers, what percentage of them would you say have Business Continuity arrangements in place to address their own needs?
        - What information do you seek in order to better understand the Business Continuity arrangements of key supplier?
        - Do you or your organization ask key suppliers (new/existing) whether they have Business Continuity arrangements in place?
    - Visibility over disruption events
        - Do you record, measure, and report on performance-affecting supply chain disruptions (i.e. where an unplanned cost has been incurred or loss of productivity or revenue experienced)?
- Collaboration:
    - How do you collect this information?

    - How have you checked/validated that key suppliers' Business Continuity arrangements might work in practice?
    - How often do you review your Business Continuity requirements with key suppliers and their capability to meet them?
    - When tendering for new business clients over the past 12 months, how often have you had to provide assurance to clients that your own Business Continuity arrangements are sufficient?
- Velocity:
    - Does your organization have its own Business Continuity arrangements in place to deal with supply chain disruption?
- Leadership and culture:
    - How would you assess your organization's top management commitment to managing supply chain risk?
    - Does Business Continuity feature as part of your supplier contractual discussions?

Finally, some contextual variables have been set for the study: Insurance, Enterprise size and industry sector are considered, and their relevant questions are provided below.

- Insurance coverage:
    - How much of the financial impact was insured?
- Company size:
    - Approximately how many employees work at your organization?
    - If you are a working in a private sector organization, please let us know the approximate annual revenues of your business.
- Industry sector:
    - Please indicate the primary activity of your organization using the SIC 2007 categories given below. (For example, a management consultancy would mark "Professional Services" only and not the sectors in which its clients operate)

3.3.1 Descriptive statistics of BCI report

As mentioned in previous section, the BCI survey includes 28 questions and 408 respondents which are came from 64 countries and 6 different industry sectors which illustrates in pie charts below.

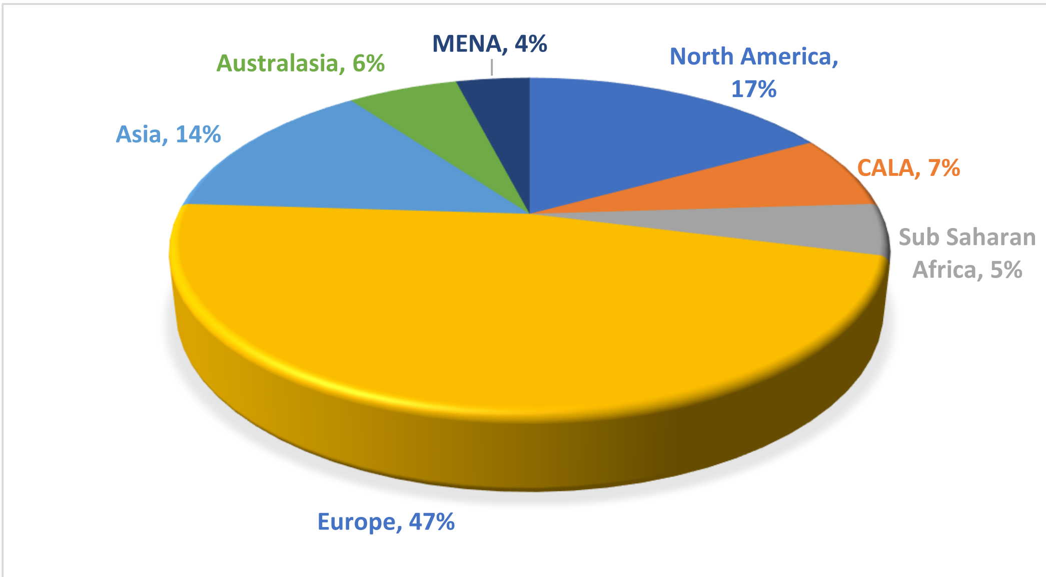

Figure 3.4: Geographical dispersion

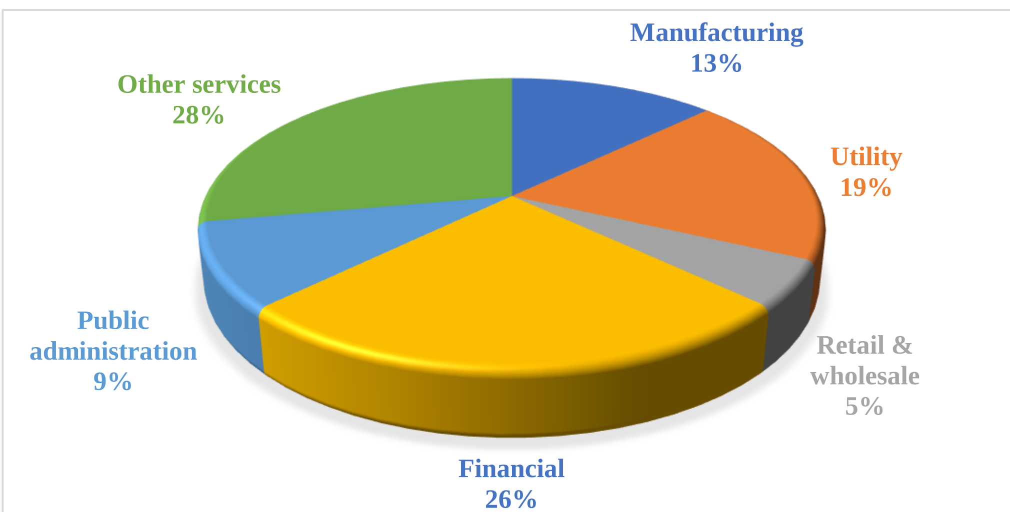

Figure 3.5: Industry sectors percentage

The focal firm size in this survey is constructed by number of employees that range [From 0-250] … [>100,000], and annual revenue ranged [From 1-10 M€] … [>50 B€] which the percentages are provided in detail by Figure 3.6 and Figure 3.7 respectively.

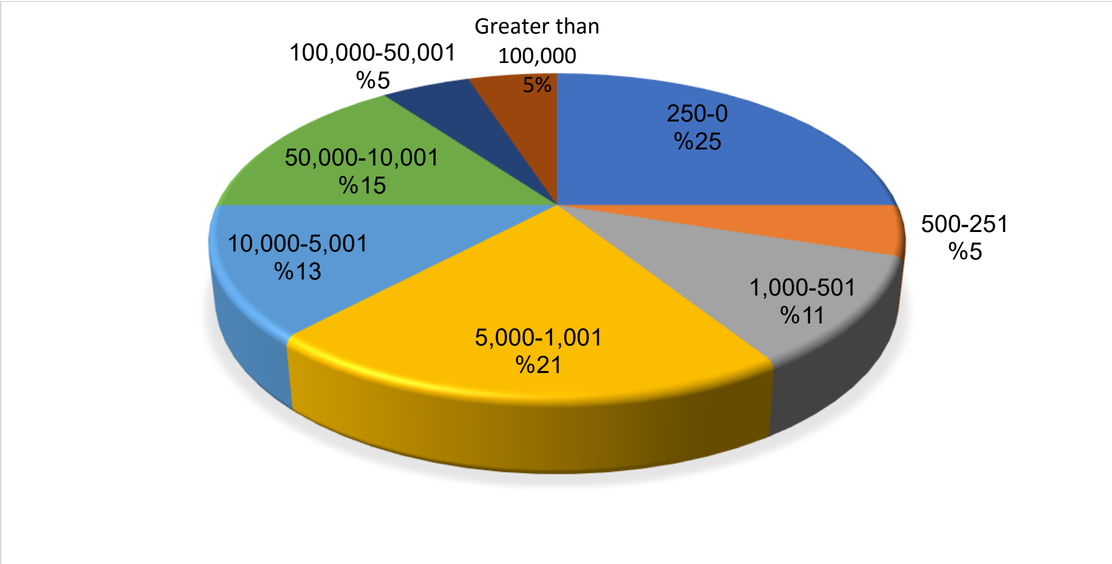

Figure 3.6: Number of employees

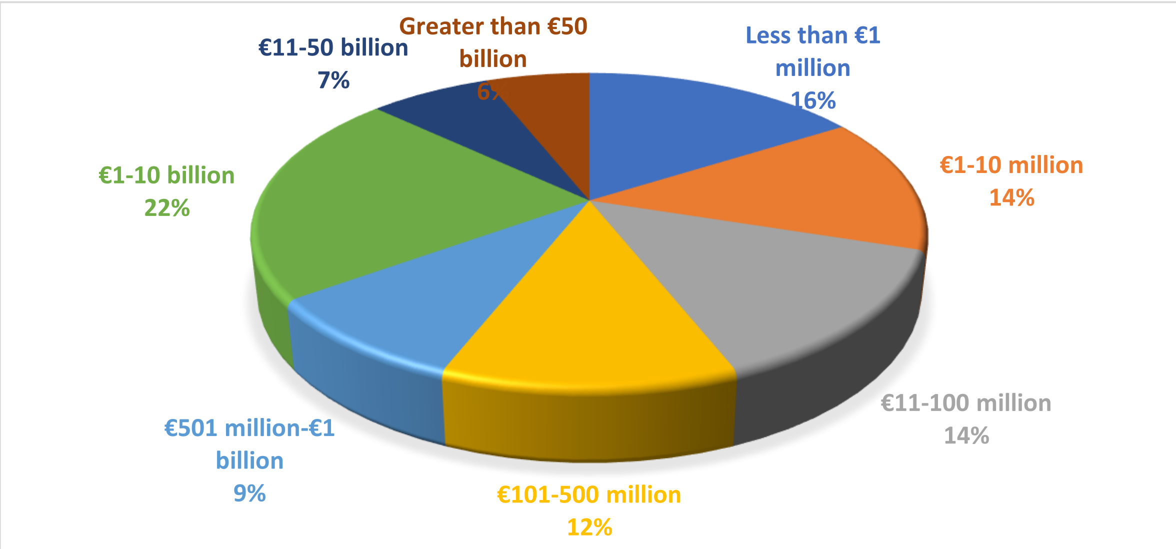

Figure 3.7: Annual revenue

The first section of report is related to supply chain disruptions and outcome of BCI survey shows that the majority of organizations (65%) have experienced at least one disruption which 31% of firm record and measure performance-affecting disruptions across the whole enterprise and 38% just reported in a certain departments/functions. Despite an increasing use of digital services by organizations, approximately 60% of them do not use any technology for analyzing, tracking and monitoring of potential the SC disruptions. Out of those who utilize technology, 41% still rely on Excel spreadsheets for keeping track of SC disruptions. More specific solutions such as incident response data (13%), third party due diligence solutions (10%), BCM software (9%) and financial solvency models (5%) complete the top five shows in Figure 3.8.

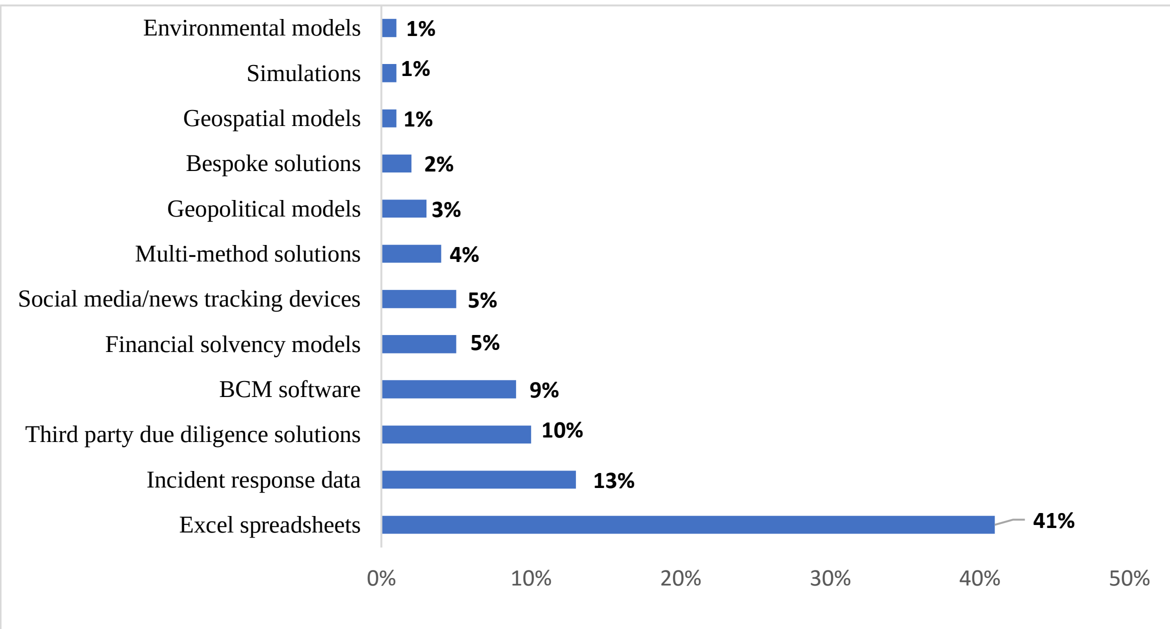

Figure 3.8: Technologies used for analyzing the SC disruptions

In addition, the predominant source of disruption across the all events in the last 12 months shows that nearly half of the respondents (44%) reported that Tier 1 suppliers as the predominant source of disruption, with almost an additional quarter (24%) stating disruptions mainly come from Tier 2 (Figure 3.9)

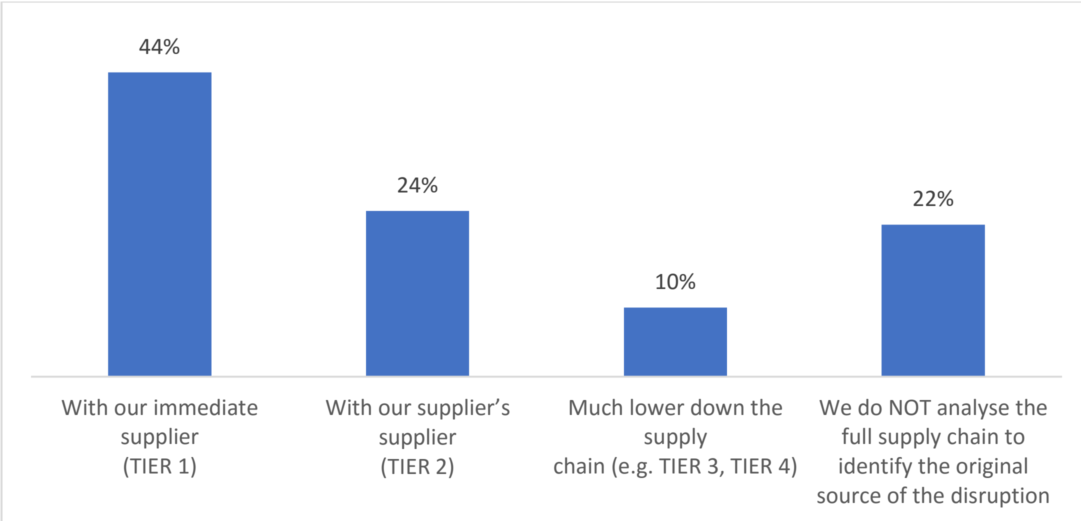

Figure 3.9: Predominant source of disruptions

Unplanned IT or telecommunications outages (48%) are still the main cause of disruption, with cyber-attacks and data breaches (40%) and loss of talent/skills completing (34%) the top three causes of disruption. In this regard, the consequence of disruption are determined in fifteen categorized which are the three top main ones are, Loss of productivity (55%), increased cost of working (46%), and customer complaints (43%) and the remaining are shown in Figure 3.10.

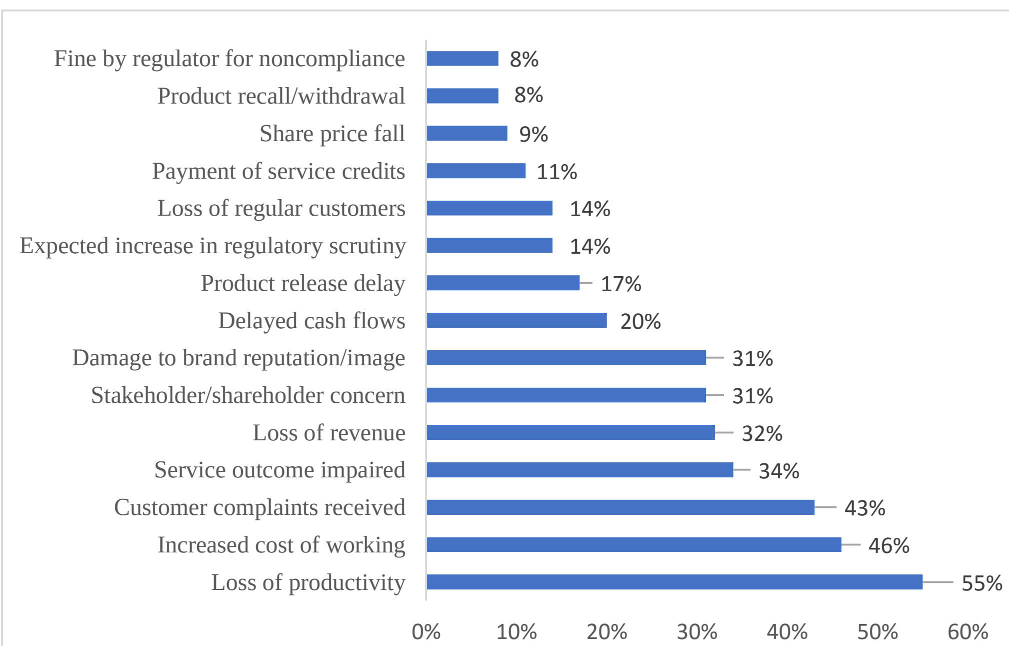

Figure 3.10: consequences of disruption

Consistent with the cause of disruption highlighted above, the horizon SC scan threats result respondents considered cyber-attacks and data breaches (60%), unplanned IT or telecommunications outage (59%) and loss of talent /skills (34%) as their main concerns for the next 12 months. From the economical perspective, more than half of respondents (53%) reported the cumulative financial losses during the past 12 months, for less than 50,000 euros, while the losses more than one million euros was determined as 22%. Nonetheless, considering the single incidents affecting SC, the losses more than 1 million euros was 23% and less than 50,000 euros was 48%. Noticeably, around 50% of the respondents asserted that their financial losses were not insured, while the percentage of organizations with fully insuring their losses is 13% (Figure 3.11)

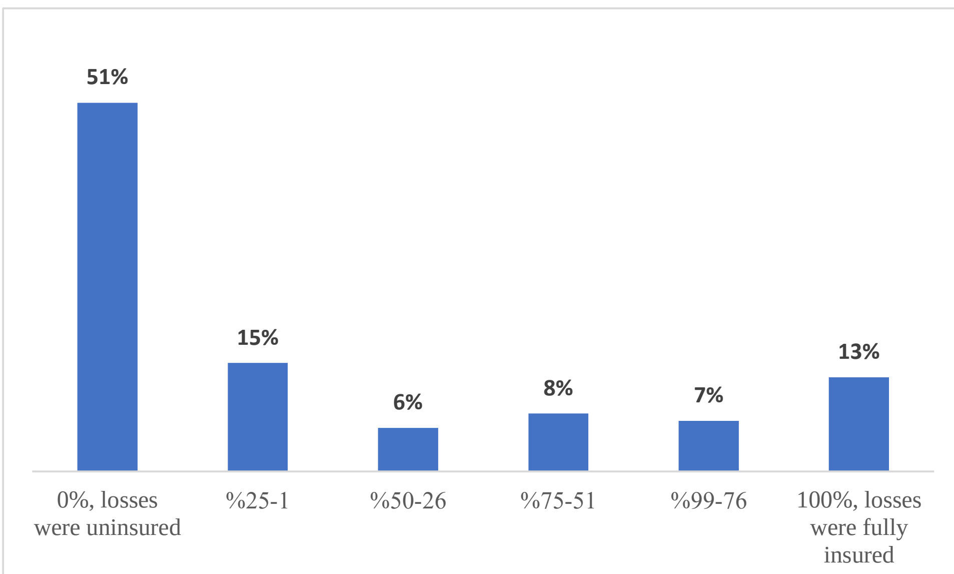

Figure 3.11: Percentage of insured financial losses

Almost three-quarters of organizations (74%) report have business continuity related to SC management in placed with threats. In doing so, the those organizations are eight times more likely to report greater SC visibility, twice more times likely to insure for SC losses and three times more likely to display the top management commitment essential to reinforcing good practice. The supplier business continuity information, shows that four out of ten organizations (38%) report having 21 or more key suppliers. Meanwhile, 2% claim having more than 1,000 key suppliers and percentage of organizations who do not identify key suppliers is around 7%. The data depicts that 74% of organizations ask their supplier (new and existing) about their business continuity arrangements that covey the concept of visibility over the supplier. Therefore, less than half of them (47%) claim that the majority of their suppliers have business continuity arrangements in place to address their own needs. On the other hand, around 10% of them asserted that all of their suppliers have business continuity in place. Seeking assurance from key suppliers is another important area of engagement between business continuity practitioners and their SC and procurement counterparts. In this vein, the half of organizations rely on recognized standards (e.g. ISO 22301), the BCM program is the second place (44%) and 42% of them asserted that compliance with recognized good practice such as BCI's Good Practice Guidelines. In addition, more than four out of ten organizations (43%) claiming that business continuity is integrated into their procurement process, whereas, the 18% of them do not mention BCM business continuity as a part of their supplier contractual discussion. Finally, the percentage of the organizations who provide client assurance through business continuity arrangements in most of tender is 49%, while the small portion (11%) is belong to those organizations who do not provide any BCM for assuring of new business client.

CHAPTER 4

STUDY METHODOLOGY

In this chapter the overall research approach is presented and justified. The encoding procedure method used to translate data into variables is discussed in the first section. In the second section, the overall approach of methodology together with the statistical model and preliminary analysis are presented. Data for this study have been considered by the BCI supply chain resilience report 2017 through conducting a survey to firms operating in a worldwide. The construct and measurement items used based on already designed survey and the dataset given in the excel spreadsheet which contains in total 28 questions regarding the supply chain disruptions and supply chain resilience and business continuity and target respondents were 408 that include manager or executive of company SC. According to the definition of BCM and SCRES constituents, the selection and allocation of each question to relevant element is done and illustrated in chapter 3.

4.1 Encoding procedure

In order to initiate the quantitative analysis, the encoding procedure should be done to have a unique data set input. Due to different types of questions and answers, relevant and logical type of code try to substitute to the choices such as binary, categorical, Liker scale with 5 points, percentage and simple numeric variables. In below this procedure is explained for all the variables that analyzed in the survey and some descriptive statistics is provided as well.

As the Table 4.1 shows, different answers of this question is coded from 1 to 15 and implement as categorical variables. Other construct of SC performance is coded according to the financial aspect (cumulative cost) of the disruptive events in SC coded from 9, that associated with Less than €50,000, to 1, that associated with Greater than €500 million is illustrated in Table 4.2.

- SC performance losses under disruptions:

- Which of the following impacts or consequences arose from the incidents/disruptions experienced in the last 12 months? Tick as many as applicable.

Table 4.1: SC performance code 1

Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Answers	Loss of revenue	Loss of regular customers	Delayed cash flows	Share price fall	Fine by regulator for non-compliance	Expected increase in regulatory scrutiny	Increased cost of working	Product release delay	Product recall/withdrawal	Service outcome impaired	Payment of service credits	Loss of productivity	Customer complaints received	Damage to brand reputation/image	Stakeholder/shareholder concern	Other (please specify)

- What was the approximate financial cost of your cumulative, as well as the most significant, supply chain incident in the last 12 months (loss of revenue and/or increased cost of working)? Please give your response in euros. Exchange rate (March 2017): 1 USD = 0.94 EUR = 0.82 GBP = 1.32 AUD = 1.35 CAD.

Table 4.2: SC performance code 2

9	8	7	6	5	4	3	2	1
Less than €50,000 - Cumulative cost	€50,001-250,000 - Cumulative cost	€250,001-500,000 - Cumulative cost	€1-10 million - Cumulative cost	€11-50 million - Cumulative cost	€51-100 million - Cumulative cost	€101-250 million - Cumulative cost	€251-500 million - Cumulative cost	Greater than €500 million - Cumulative cost

The SC vulnerability that constructed by the number of incidents that the focal company experienced in the past year is coded from 5 till 0 according to the different number of incidents in Table 4.3. The second constructs is related to level of severity such as high impact, some impact, low impact and not applicable which coded from 1 till 3 consequently and for the "not applicable" the code 0 is considered. In addition the different source of disruptions such as adverse weather, Earthquake/tsunami, Fire, Currency exchange rate volatility, Act of terrorism, Human illness, Animal disease, Lack of credit, Insolvency in the supply chain, Intellectual Property violation, Cyber-attack and data breach, Unplanned IT or telecommunications outage, Industrial dispute, Civil unrest/conflict, New laws or regulations, Energy scarcity (i.e. loss of supply or rapid price increase), Transport network disruption, Environmental incident (e.g. pollution, waste management), Health & Safety incident, Product quality incident (e.g. product recall), Business ethics incident (e.g. human rights, corruption), Loss of talent/skills, Outsourcer failure. In the Table 4.4 those source of disruptions are listed and each respondent select among them and ranked each one based on the different impact (high impact, some impact, low impact and not applicable). The number of impact is counted for each respondent and impact the coded procedure done based on the weighted sum application (Impact * Frequency) and normalized to have the ration between [0,1].

- SC vulnerability:
    - How many supply chain incidents would you estimate your organization experienced in the past 12 months that caused a significant disruption?

Table 4.3: SC vulnerability code 1

Answers	0 (We have not had any disruption in our supply chain in the past 12 months.)	1-5	6-10	11-20	21-50	51+	I don't know
Count	92	184	28	10	7	3	37
%	25%	51%	8%	3%	2%	1%	10%
Code	5	4	3	2	1	0	0

- How severely has your supply chain been affected by any of the following sources of disruption over the past 12 months? (Severity levels can be considered in terms of initial impact, ability to continue to deliver key products and services, and recovery time, as well as the consequences on brand and reputation.)

Table 4.4: SC vulnerability code 2

Code		Adverse weather	Earthquake/tsunami	Fire	Currency exchange rate volatility	Act of terrorism	Human illness	Animal disease	Lack of credit	Insolvency in the supply chain	Intellectual Property violation	Cyber attack and data breach	Unplanned IT or telecommunications outage	Industrial dispute	Civil unrest/conflict	New laws or regulations	Energy scarcity (i.e. loss of supply or rapid price increase)	Transport network disruption	Environmental incident (e.g. pollution, waste management)	Health & Safety incident	Product quality incident (e.g. product recall)	Business ethics incident (e.g. human rights,corruption)	Loss of talent/skills	Outsourcer failure
1	High impact	For each answer the number of impacts (High, some …) are counted and the weighted sum (impact*frequency) and finally normalized																						
2	Some impact																							
3	Low impact																							
0	Not applica ble																							

- Visibility:

  The first element of visibility over risk is coded as a binary variable that shown in Table 4.5. The second element is evaluated the different tools and solutions such as BCM software, Environmental models, Excel spreadsheets, Financial solvency models, Geopolitical models, Geospatial models, Incident response data, Social media/news tracking devices and Third party due diligence solution considered as tracking and monitoring means towards the potential issues and coded in a numerical variables from 1 to 6 that shown in Table 4.6.

  - Visibility over risk:
    - Do you use technology (e.g. risk analytics indicators) to analyze, track or monitor potential performance-affecting supply chain issues that could cause disruptions?

Table 4.5: Visibility over risk code 1

	YES	NO
Count	130	222
%	0.34	0.63
Code	1	0

    - What types of solutions do you rely on to analyze, track or monitor potential issues causing supply chain disruptions? (Please indicate all that apply)

Table 4.6: Visibility over risk code 2

	BCM software	Environmental models	Excel spreadsheets	Financial solvency models	Geopolitical models	Geospatial models	Incident response data	Other (please specify)	Social media/news tracking devices	Third party due diligence solution
Count	16	1	68	9	5	2	22	14	8	15
%	10%	0.625%	42.5%	5.6%	3.1%	1.2%	14%	8%	5%	9.3%
Code	6	5	3	4	5	5	3	1	1	2

Regarding the visibility over suppliers, the first element associated with the key suppliers BCM arrangements with represented in Table 4.7 and the percentage range and encoded in categorical variables from 0 till 6. The second element is focus on the different type of information that firms seek to better understand the BCM implementation and arrangement of their key suppliers. certification to a recognized standard (e.g. ISO 22301), compliance with recognized good practice (e.g. BCI's Good Practice Guidelines), alignment to a recognized standard (e.g. ISO 22301), credentials of those who run the BCM program, where responsibility for BCM is held in the organization, A BCM program not just a business continuity plan, A program that is relevant to the product/service we are buying, the scope of their BCM program (i.e. whether it is appropriate) and a business continuity plan only are those choices for that question and each respondent choose among them (more than one choice is also selected), therefore, for each respondent all the selected choices counted and considered as a first variable and final column of variable will be calculated in a similar manner that illustrated in Table 4.8. The last constructs shown in Table 4.9, is the "YES", "NO" question about the implementation of supplier BCM and encoded as a binary variable. Finally, the visibility over the events which illustrated in Figure 4.10, are encoded in a categorical variables as 0,1 and 2.

- Visibility over suppliers
  - Considering your key suppliers, what percentage of them would you say have Business Continuity arrangements in place to address their own needs?

Table 4.7: Visibility over supplier code 1

Answer	100%	11-25%	26-50%	51-75%	76-99%	Less than 10%	Don't know
Count	22	34	44	42	48	44	44
%	8%	12%	16%	15%	17%	16%	16%
code	6	2	3	4	5	1	0

  - What information do you seek in order to better understand the Business Continuity arrangements of key supplier?

Table 4.8: Visibility over supplier code 2

Answer	certification to a recognised standard (e.g. ISO 22301).	compliance with recognised good practice (e.g. BCI's Good Practice Guidelines).	alignment to a recognised standard (e.g. ISO 22301).	credentials of those who run the BCM program.	where responsibility for BCM is held in the organization.	a BCM program not just a business continuity plan.	a program that is relevant to the product/service we are buying.	the scope of their BCM program (i.e. whether it is appropriate).	a business continuity plan ONLY.
Count	106	111	132	67	87	116	93	105	45
%	26.0%	27.2%	32.4%	16.4%	21.3%	28.4%	22.8%	25.7%	11.0%
Code	Each respond marked one of those choices and finally total number of chosen are counted for each row								

- Do you or your organization ask key suppliers (new/existing) whether they have Business Continuity arrangements in place?

Table 4.9: Visibility over supplier code 3

Answer	Don't know	YES	NO
Count	28	210	47
%	10%	73%	16%
Code	0	1	0

- Visibility over disruption events
  - Do you record, measure, and report on performance-affecting supply chain disruptions (i.e. where an unplanned cost has been incurred or loss of productivity or revenue experienced)?

Table 4.10:Visibility over events code

Answer	YES, this is coordinated and reported across the whole enterprise	NO	YES, but within certain departments/functions, but NOT aggregated
Count	112	110	133
%	32%	31%	37%
Code	2	0	1

The first question allocated to collaboration is considered different ways regarding the collecting the BCM information and each respond asked to choose them and for each row, the number of chosen answers is count and in Table 4.11 more detail is provided. Furthermore, the way which firms follow such as : ran desktop exercises, held workshops, checked pre-test scope and post-test reports, documented outcome reports and action plans, observed exercises conducted by suppliers and joint exercises based around likely scenarios, to validate/check the arrangement of key suppliers BCM is shown in Table 4.12. In addition, the number of choices selected by each respondent is counted and considered for further analysis. The frequency of key supplier BCM evaluation is asked in the next questions and encoded similar to previous question (Table 4.13). Finally, the last construct of collaboration is contributed with providing the insurance to clients ,when tendering for the new business, that the BCM of the firm is sufficient enough, encoded in a categorical variable that ranged from to 4 shown in Table 4.14.

- Collaboration:
    - How do you collect this information?

Table 4.11: Collaboration code 1

Answer	provide them with a self-assessment questionnaire.	require copies of supplier documentation.	audit them.	request an independent audit.	don't collect any information.
Count	157	127	79	36	39
%	36%	26%	18%	8%	9%
Code	*Each respond marked one of those choices and finally total number of chosen are counted for each row*				

- How have you checked/validated that key suppliers' Business Continuity arrangements might work in practice?

Table 4.12: Collaboration code 2

Answer	ran desktop exercises.	held workshops.	checked pre-test scope and post-test reports.	documented outcome reports and action plans.	observed exercises conducted by suppliers.	joint exercises based around likely scenarios.	have NOT checked/validated their plans.
Count	54	38	53	60	39	59	127
%	13%	9%	12%	14%	9%	14%	30%
Code	*Each respond marked one of those choices and finally total number of chosen are counted for each row*						

- How often do you review your Business Continuity requirements with key suppliers and their capability to meet them?

Table 4.13:Collaboration code 3

Answer	Ad hoc	Scheduled review meetings with key suppliers	A major change event at our end	A major change event at their end	A new, significant external risk/threat is identified	At contract renewal	Never
Count	69	97	50	41	49	105	35
%	17%	24%	12%	10%	12%	26%	9%
Code	Each respond marked one of those choices and finally total number of chosen are counted for each row						

- When tendering for new business clients over the past 12 months, how often have you had to provide assurance to clients that your own Business Continuity arrangements are sufficient?

Table 4.14: Collaboration code 4

Answer	Don't know	Not applicable	Every tender/proposal (100%)	Majority (51-99%)	Not at all (0%)	Rarely (1-24%)	Sometimes (25-50%)
Count	34	23	40	51	31	50	41
%	13%	9%	15%	19%	11%	19%	15%
Code	-	0	4	3	0	1	2

The question related to the SC velocity that mainly considered the BCM arrangement of the focal company to deal with supply chain disruptions is encoded in a binary variable and shown in Table 4.15.

- Velocity:
  - Does your organization have its own Business Continuity arrangements in place to deal with supply chain disruption?

Table 4.15:Velocity code

Answer	YES	NO	Don't know
Count	220	56	132
%	54%	14%	32%
Code	1	0	-

The concept and BCM organizational culture is investigated through, top management commitment level to BCM , that encoded in a categorical variable ranged from 1 to 4 (Table 4.16) , and the evaluation of BCM as a contractual obligation and features of the organization represent in Table 4.17 and encoded in a binary variable.

- Leadership and culture:
  - How would you assess your organization's top management commitment to managing supply chain risk?

Table 4.16: Leadership and culture code 1

Answer	Don't know	High	Low	Medium	None
Count	14	106	68	79	8
%	5%	38%	24%	28%	3%
Code	1	4	2	3	1

  - Does Business Continuity feature as part of your supplier contractual discussions?

Table 4.17: Leadership and culture code 2

Answer	NO	YES, but after the purchase decisions have essentially been taken	YES, but only where the contract risk is deemed high	YES, it is an integral part of our procurement process from the start
Count	49	41	63	115
%	18%	15%	24%	43%
Code	0	1	1	1

In the analysis of the survey, the contextual variables such as: Insurance, Enterprise size and industry sector are considered. The insured financial impact of the disruptive events shown in Table 4.18 and encoded in six categorical variables.

- Insurance coverage:
    - How much of the financial impact was insured?

Table 4.18: Insurance coverage code

Answer	0%, losses were uninsured	100%, losses were fully insured	1-25%	26-50%	51-75%	76-99%	I don't know
Count	89	22	26	11	14	13	90
%	34%	8%	10%	4%	5%	5%	34%
Code	0	5	1	2	3	4	0

According to BCI supply chain resilience report 2017, the company size that considered in this dissertation, the number of employees that illustrated in eight categorical variables, shown in Table 4.19. Besides, the financial perspective of organization evaluated through the annual revenues that categorized in seven variables that depicted in Table 4.20.

- Company size:
    - Approximately how many employees work at your organization?

Table 4.19: Company size code 1

Answer	0-250	251-500	501-1,000	1,001-5,000	5,001-10,000	10,001-50,000	50,001-100,000	Greater than 100,000
Count	103	19	43	87	54	60	20	22
%	25%	5%	11%	21%	13%	15%	5%	5%
Code	1	2	3	4	5	6	7	8

    - If you are a working in a private sector organization, please let us know the approximate annual revenues of your business.

Table 4.20: Company size code 2

Answer	€1-10 million	€11-100 million	€101-500 million	€501 million-€1 billion	€1-10 billion	€11-50 billion	Greater than €50 billion
Count	36	37	32	22	58	18	15
%	17%	17%	15%	10%	27%	8%	7%
Code	1	2	3	4	5	6	7

Finally, the different primary industry sectors are illustrated in Table 4.21 and encoded in six different categorical variables.

- Industry sector:
    - Please indicate the primary activity of your organization using the SIC 2007 categories given below. (For example, a management consultancy would mark "Professional Services" only and not the sectors in which its clients operate)

Table 4.21: Industry sector code

Answer	Manufacturing	Utility	Retail & wholesale	financial	Public administration	Other services
Count	53	79	21	106	39	115
%	13%	19%	5%	26%	9%	28%
Code	1	2	3	5	6	4

Table 4.22 provides the correlations of relevant variables which encoded in this study. Obviously, there is no exaggerated correlations (>0.9) among the constituents and with this outcome, the PLS-SEM model applied (reported in the following section and the result will be precisely explained in the next chapter).

Table 4.22: Multivariate correlations

	VoE	VoS1	VoS2	VoS3	COL1	COL2	COL3	COL4	VoR1	VoR2	TMC1	TMC2	PLR1	PLR2	VUR1	VUR2	VEL
VoE	1																
VoS1	0.015	1															
VoS2	0.002	0.751	1														
VoS3	0.015	0.841	0.815	1													
COL1	0.017	0.779	0.853	0.725	1												
COL2	0.021	0.483	0.454	0.527	0.513	1											
COL3	0.03	0.75	0.734	0.806	0.801	0.594	1										
COL4	0.008	0.761	0.743	0.747	0.761	0.554	0.728	1									
VoR1	0.049	0.592	0.568	0.508	0.531	0.278	0.447	0.438	1								
VoR2	0.013	0.124	0.123	0.16	0.137	0.197	0.182	0.15	0.33	1							
TMC1	0.002	0.853	0.824	0.767	0.786	0.412	0.661	0.691	0.517	0.135	1						
TMC2	0.042	0.91	0.893	0.876	0.618	0.519	0.794	0.815	0.537	0.116	0.791	1					
PLR1	0.004	0.794	0.765	0.678	0.708	0.461	0.661	0.599	0.513	0.171	0.701	0.724	1				
PLR2	0.035	0.491	0.488	0.427	0.447	0.321	0.405	0.473	0.285	0.119	0.443	0.49	0.469	1			
VUR1	0.074	0.457	0.433	0.407	0.406	0.229	0.378	0.362	0.678	0.221	0.423	0.421	0.396	0.38	1		
VUR2	0.02	0.571	0.537	0.494	0.518	0.253	0.409	0.407	0.544	0.1	0.506	0.504	0.506	0.361	0.439	1	
VEL	0.003	0.814	0.788	0.747	0.762	0.42	0.651	0.673	0.501	0.106	0.781	0.759	0.667	0.492	0.477	0.527	1

In addition to the provided preliminary analysis the Exploratory Factor Analysis (EFA) is done by the SPSS software in order to identify the relationship among measured variables. The result of EFA analysis is shown in Table 4.23 with the rotated components matrix. Theoretically, the rotated component is calculated in 7 different categories which affirms the level of coherent and the uniqueness of the variables categorization.

Table 4.23: Rotated component matrix

Rotated Component Matrixa							
	1	2	3	4	5	6	7
VOS1	0.803						
VOS2	0.788						
VOS3	0.746						
COL1		0.835					
COL2		0.769					
COL3		0.691					
COL4		0.650					
VUR1			0.727				
PLR1			0.721				
PLR2			0.669				
VUR2			0.658				
VoR1				0.888			
VoR2				0.885			
TMC1					0.640		
TMC2					0.622		
VoE						0.580	
VEL							0.449
Extraction Method: Principal Component Analysis.							
Rotation Method: Varimax with Kaiser Normalization.							
A rotation converged in 5 iterations.							

Overall, the data set that included all encoded variables (18 column of data) used as an input data set for implementing the Partial Least Square (PLS) based on Structural Equation Modeling (SEM) by SmartPLS software package version 3. Notably, for those questions that respondent did not answer (or missing value) specific value such as -99 was inserted that does not appear in whole data set. In following section more explanation and analysis are provided.

4.2 Overall approach and preliminary analysis

In this dissertation, the partial least square (PLS) approach based structural equation modelling (SEM) is used (PLS-SEM model). The application of the PLS approach in SCRES and its elements analysis is not uncommon. In this context, there are two main approach towards choosing the PLS method. PLS over variance-based SEM and PLS over covariance based. In this dissertation, to analyze the research HP model the second approach (SEM-PLS and covariance based) is selected based on main reasons that provided below:

- It is suitable for small sample size data analysis (Grötsch et al., 2013);
- It is relatively more effective to perform moderation effects analysis (Wetzels et al., 2009);
- It enables to deal with formative multilevel constructs that are not easy to be dealt with in a single covariance-based SEM model (Peng and Fujun, 2012); and
- To analyze the model, the property of multivariate normal distribution of data is not required.

The data set includes the coded questions used as the input for the software. A path model consists of two elements. The structural model represents the structural paths between the constructs, whereas the measurement models represent the relationships between each construct and its associated indicators. In PLS-SEM, structural and measurement models are also referred to as inner and outer models (Sarstedt et al., 2017). Each elements of SCRES constituents considered in this study constructed as reflective model for the exogenous variables (TMC, SIZE, INS and SEC) and endogenous ones (COL, VoR, VoS, VoE and VEL). Both reflective models for VUR and PLR are illustrated in Figure 4.1 and Figure 4.2.

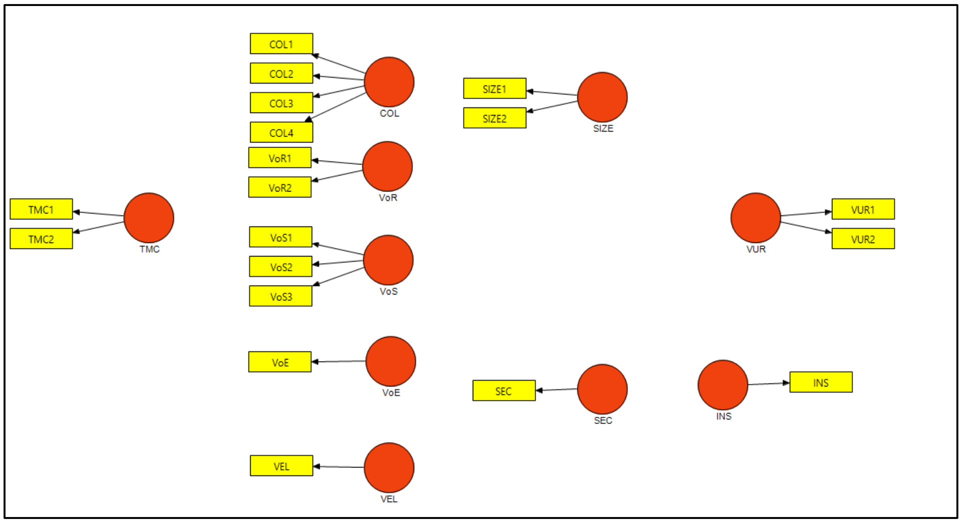

Figure 4.1: Reflective model for VUR

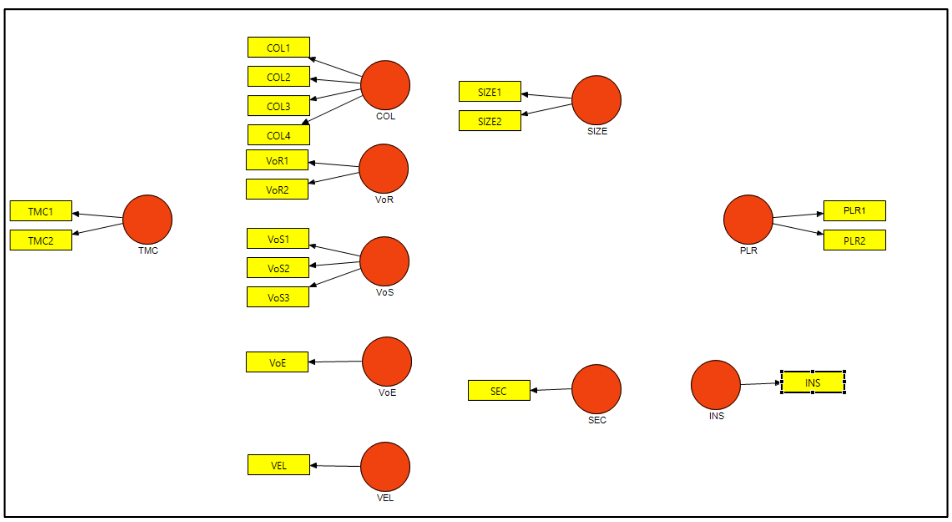

Figure 4.2: Reflective model for PLR

The reflective measurement model has a long tradition in the social sciences and is directly based on classical test theory. According to this theory, measures represent the effects (or manifestations) of an underlying construct (Hair, Jr. et al., 2017). Furthermore, it can be viewed as a representative sample of all the possible items available within the conceptual domain of the construct. Basically, all indicator items are caused by the same construct and highly correlated with each other in reflective measurement context. In addition, due to the concept of reflective model each individual items could be interchangeable, and any single item can generally be left out without changing the meaning of the construct. In contrast, formative measurement models are based on the assumption that causal indicators form the construct by means of linear combinations (Hair, Jr. et al., 2017). Fundamentally, an important characteristic of formative indicators is that they are not interchangeable, as is true with reflective indicators. Thus, each indicator for a formative construct captures a specific aspect of the construct's domain and omitting an indicator potentially alters the nature of the construct (Hair, Jr. et al., 2017).

According to provided comparison between reflective and formative measurement, the main reason to construct each variable based on reflective model is that, the questionnaire is already design by BCI and allocation of questions to both exogenous and endogenous variables is done based on the logical and conceptual understanding. Furthermore, the reflective measurement model assessment ensure the reliability and validity of the construct measures (TMC, COL, VoR, VoS, VoE, VEL, PLR and VUR) and therefore provide support for the suitability of their inclusion in the path model (Hair, Jr. et al., 2017). In addition, one of the main advantages of the PLS-SEM model is creating, analyzing and evaluating the effect of moderation and mediation variables in a straightforward manner (Hair, Jr. et al., 2017). According to the study of (Hair, Jr. et al., 2017) on PLS-SEM model implementation, A mediating effect is created when a third variable or construct intervenes between two other related to test if there is direct relationship among two certain variables or , the indirect relationship with mediating effect of third variable is existing. Thus, this indirect effect is characterized as the mediating effect. For instance, in this dissertation the mediating effect among the TMC and two target variables (PLR and VUR) through SCRES constituents is considered in a PLS-SEM model. On the other side, the moderation is a third variable could directly affect the relationship between the exogenous and endogenous latent variables but in a different way (Hair, Jr. et al., 2017). Referred to as a moderator effect, this situation occurs when the moderator (an independent variable or construct) changes the strength or even the direction of a relationship between two constructs in the model. With this perspective, the moderation effect assumed between contextual variables such as SIZE, INS and SEC and the target variables (PLR and VUR) and analyzed through HP4, HP5 and HP6. Consequently, both the mediator and the moderator concept affect the strength of a relationship between two latent variables (Hair, Jr. et al., 2017) and the crucial distinction between both concepts is that the moderator variable (contextual variables) does not depend on the exogenous (predictor) latent variable (PLR and VUR) (Hair, Jr. et al., 2017). The PLS-SEM algorithm uses the empirical data for the indicators and iteratively determines the construct scores, the path coefficients, indicator loadings and weights, and further statistics such as R^2 values. Specifically, after determining the scores for every construct, the algorithm estimates all remaining unknown relationships in the PLS path model. The algorithm first obtains the measurement model results, which are the relationships between the constructs and their indicator variables. Then, the algorithm calculates the path coefficients, which are the relationships between the constructs in the structural model, along with the R^2 values of endogenous constructs. All results are standardized, meaning that, for example, path coefficients can be compared with each other. Moreover, the resulting construct scores are then used to estimate all partial regression models in the structural model and the measurement models to obtain the final model estimates. In Figure 4.3 the path coefficient for each relationships with R^2 values (in blue circles) are illustrated for the model 1 (PLR) and in similar manner for the model 2 (VUR) is shown in Figure 4.4.

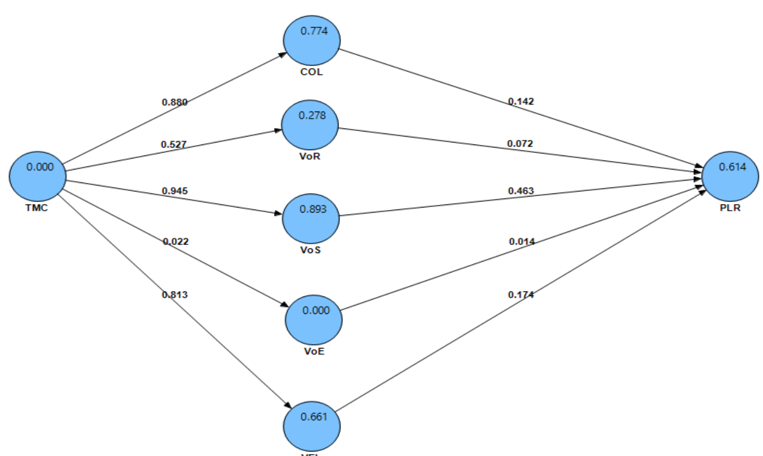

Figure 4.3: PLS Algorithm model 1

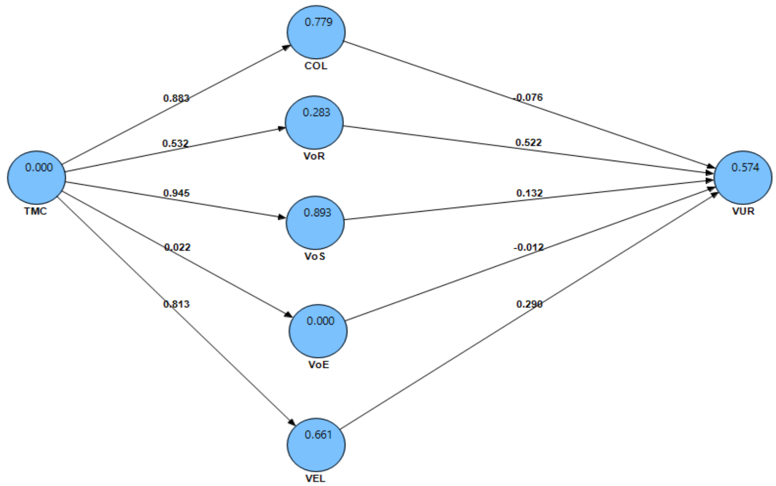

Figure 4.4: PLS Algorithm model 2

Fundamentally, in order to estimate the significance of path coefficients and item weights the bootstrapping is used. Basically, in bootstrapping with replacement _ means that each time an observation is drawn at random from the sampling population, it is returned to the sampling population before the next observation is drawn

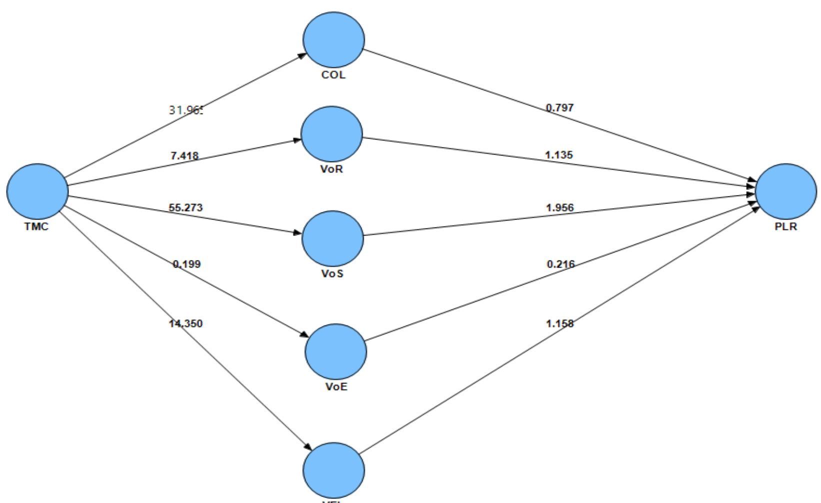

Figure 4.5 Bootstrapping Algorithm model 1

(i.e., the population from which the observations are drawn always contains all the same elements) _from the original set of data and each subsample is then used to estimate the model. This process is repeated until a large number of random subsamples have been created, in this dissertation 500 random sample was considered. In Figure 4.26 the bootstrapping method implemented by SmartPLS software for the model 1 , along with their critical t-value that represented above each relationship (arrow).

In a similar evaluation, the bootstrapping method is applied for the model 2 that critical t-values and relationships are shown in Figure 4.6. It is worth mentioning that those abovementioned models are the general consideration without evaluating the moderating and mediating effect of contextual variables and TMC. The separate models for testing the moderation and mediation variables are created which further detail will provide along with statistical analysis and relevant explanation regarding the final result in chapter 5.

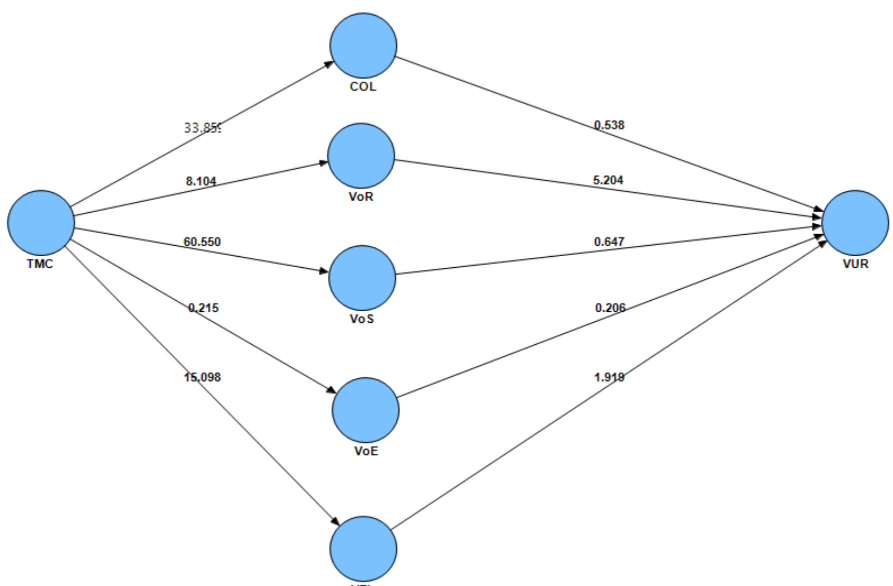

Figure 4.6: Bootstrapping Algorithm model 2

CHAPTER 5

RESULTS

The results of this dissertation are articulated in two parts. In the first one the hypotheses related to first model that analyzing the contribution of BCM on PLR. In The second one, the hypotheses related to the second model which considered the contribution of BCM on VUR. Furthermore, in providing results gained from two models the following parameters are evaluating in separate model: a) the mediation effect of TMC through the SCRES constituents on PLR and VUR; b) the moderation effect of contextual variables on PLR and VUR. Finally the conceptualization matrix of BCM and SCRES constituents is provided along with relevant contribution and result. In order to explain and taken into account different aspects of gained result, it is worth mentioning to brief explanation of basic elements. The significance of each evaluated models in this study is assessed by evaluating the p-value. A p-value of 0.05 has been considered as reference and significance level. Thus, for the p-value lower than 0.1, it is possible to reject the null hypothesis with 90 percent of confidence. The rejection of the null hypothesis implies that the model presents meaningful relationships. Furthermore, the adjusted R^2 is utilized in order to understand the degree of coverage of the variance of data granted by the model. Therefore, for every model, the evaluation of the significance of every relationship between the dependent and the independent variables is carried out. As considered above, for each coefficient β, the bootstrapping method with sampling size of 500 is applied in order to evaluate the level of significance for each coefficient in confidence interval of 90%. Regarding, the validity procedure and quality of models, the report that created, at the end of model implementation, by SmartPLS is considered for each model. The first step in assessing reflective measurement models addresses convergent validity, which is the extent to which a construct converges in its indicators by explaining the items' variance. Convergent validity is assessed by the average variance extracted (AVE) across all items associated with a particular construct and is also referred to as communality (Sarstedt et al., 2017). The AVE is calculated as the mean of the squared loadings of each indicator associated with a construct (for standardized data). An acceptable threshold for the AVE is 0.50 or higher. This level or higher indicates that, on average, the construct explains (more than) 50% of the variance of its items (Sarstedt et al., 2017). Another measure of internal consistency reliability is Cronbach's alpha that assumes the same thresholds but yields lower values than the composite reliability. Generally speaking, the Cronbach's alpha higher than 0.5 would be in acceptable range. The third criterion that considered in this context is the composite reliability that higher values indicate higher levels of reliability. For instance, the value between 0.60 and 0.70 considered as "acceptable in exploratory research," whereas results between 0.70 and 0.95 represent "satisfactory to good" reliability levels (Sarstedt et al., 2017).

5.1 Result gained from model 1

The hypotheses proposed in the research framework regarding the model 1, that shown in Figure 5.1, tested by simple and multiple linear regression models, using the statistical software SmartPLS 3. The primary aim is to estimate the weight of the independent variable (PLR) on the depend variables (TMC, COL, VoR, VoS, VoE and VEL) and concerning the effect of contextual variables effect. In the first step, the basic model (without moderation and mediation effect) is created among the variables. The evaluation of the PLS-SEM results begins with an assessment of the reflective measurement model 1 and the outcome is shown based on path coefficient in Table 5.1.

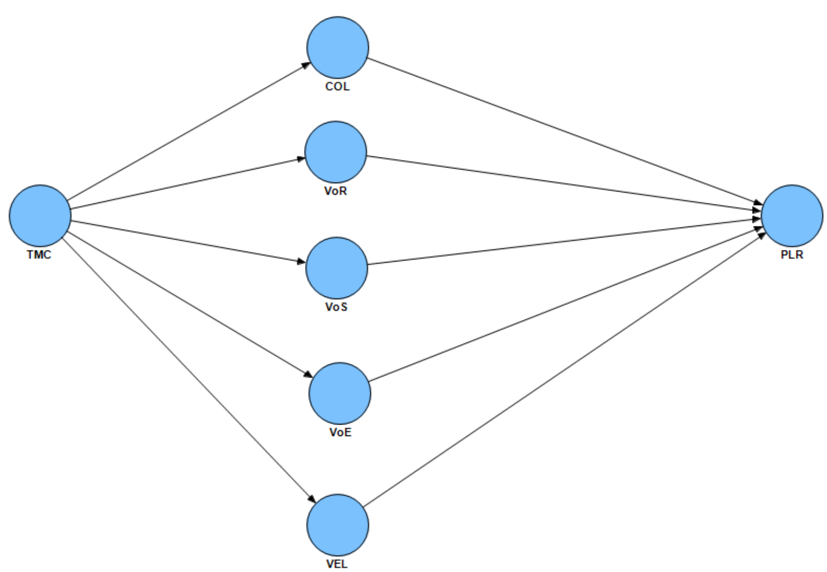

Figure 5.1: Model 1 elements and relationships

Table 5.1: Path coefficient of model 1

	COL	PLR	TMC	VEL	VoE	VoR	VoS
COL	0	0.142	0	0	0	0	0
PLR	0	0	0	0	0	0	0
TMC	0.8797	0	0	0.8127	0.022	0.5271	0.9452
VEL	0	0.1737	0	0	0	0	0
VoE	0	0.0142	0	0	0	0	0
VoR	0	0.0719	0	0	0	0	0
VoS	0	0.4626	0	0	0	0	0

Theoretically, all the provided path coefficient is positive and affirms the positive relationship among the TMC to BCM and SCRES constituents (COL, VEL, VoE, VoR and VoS) and positively influence of SCRES constituents on PLR. All the outer loadings of both exogenous and endogenous variables are evaluated and shown in Table 5.2. Furthermore, all the outer loadings are positive and above 0.70, indicating that all indicators exhibit a sufficient level of reliability (i.e.,>0.50) and affirms the suitable level of relevance among the variables and their components.

Table 5.2:Outer loadings of model 1

	COL	PLR	TMC	VEL	VoE	VoR	VoS
COL1	0.9138	0	0	0	0	0	0
COL2	0.7223	0	0	0	0	0	0
COL3	0.9125	0	0	0	0	0	0
COL4	0.8917	0	0	0	0	0	0
PLR1	0	0.9147	0	0	0	0	0
PLR2	0	0.7858	0	0	0	0	0
TMC1	0	0	0.9419	0	0	0	0
TMC2	0	0	0.9506	0	0	0	0
VEL	0	0	0	1	0	0	0
VoE	0	0	0	0	1	0	0
VoR1	0	0	0	0	0	0.9702	0
VoR2	0	0	0	0	0	0.5489	0
VoS1	0	0	0	0	0	0	0.9784
VoS2	0	0	0	0	0	0	0.9693
VoS3	0	0	0	0	0	0	0.9213

In order to assess the validation of model 1, the result of evaluation based on PLS-SEM model is provided in Table 5.3

Table 5.3: Validity matrix for model 1

	AVE	Composite Reliability	R Square	Cronbachs Alpha
COL	0.7461	0.921	0.7739	0.8853
PLR	0.727	0.8412	0.614	0.6382
TMC	0.8954	0.9448	0	0.8833
VEL	1	1	0.6606	1
VoE	1	1	0.0005	1
VoR	0.6213	0.7529	0.2778	0.4963
VoS	0.9152	0.97	0.8934	0.9534

Based on the AVE for the model 1, all the variables have the value higher than 0.5 that means on average the construct can capture more than 50% of the variance of its items, for instance the COL components such as COL1, COL2, COL3 and COL4 have the capability to capture the total variance of the COL. In doing so, the same explanation can be provided for the rest of variables as well. The second criteria to assess the quality of model, is the composite reliability which affirms the level of reliability of each variable. Theoretically, all the considered variables are in acceptable range of composite reliability. The third criterion is R^2 that evaluated in a similar manner in order to understand the degree of coverage of the variance of data granted by the model and based on theory explained before, all the variables have the acceptable level of R^2 (the more closer to 1, the better) except the VoE with considerably low (0.0005) that statically means this component is not remarkably capable to capture the variability of VoE (Sarstedt et al., 2017). The last criterion is Cronbach's alpha which measure of internal consistency reliability and according to explanation in previous section, the value of this element for all the variables is in category of satisfactory (between 0.7 and 0.95) and acceptable (between 0.6 and 0.7) categories (Sarstedt et al., 2017). Noticeably, in three criterions such as AVE, Composite Reliability and Cronbach's alpha for both VEL and VoE the value shown in Table 5.3 is equal to 1. Mainly, those variables constructed by merely one component as VEL1 and VoE1 respectively; therefore, all the variability are explained and captured through those components. The level of significant of each coefficient in model 1 evaluated through bootstrapping with sample size of 500. In Table 5.4 the value of t-statistics is provided and based on already defined the confidence interval as 90% and its corresponding t-statistics = 1.6, the variables which are higher than 1.6 are considered as statistically significant and their effect (coefficient) must be taken into consideration in interpretation of model and its HPs.

Table 5.4: Bootstrapping result for model 1

	COL	PLR	TMC	VEL	VoE	VoR	VoS
COL	0	1.701	0	0	0	0	0
PLR	0	0	0	0	0	0	0
TMC	31.17	0	0	14.093	0.215	7.525	62.937
VEL	0	1.187	0	0	0	0	0
VoE	0	0.224	0	0	0	0	0
VoR	0	1.104	0	0	0	0	0
VoS	0	1.931	0	0	0	0	0

Based on the provided result, the conclusion could be drawn in three categories such as: highly significant, partially significant and not significant. The highly significant relationship among these variables: TMC→COL, TMC→VoR, TMC→VoS, TMC→VEL and VoS→PLR with t-student value higher than 1.6. The partially significant relationship is among these variables: COL→PLR, VoR→PLR, and VEL→PLR with the t-student is considerably close to 1.6. Finally, the not significant relationships are considered among

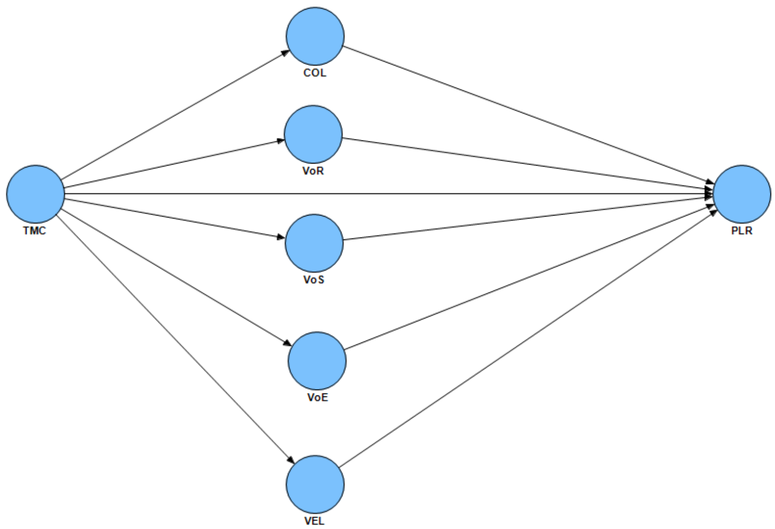

Figure 5.2: Mediation effect of TMC on PLR

TMC→VoE and VoE→PLR which their t-student value is remarkably lower than 1.6. In addition to the basic model, the separate model is created to assess the mediation effect of the TMC on PLR. For this purpose, the new model is considered with the both direct relationship of TMC on PLR (TMC→PLR) and the mediation effect of TMC on PLR through the SCRES constituents (TMC→SCRES constituents→PLR) that illustrated in Figure 5.2. Afterwards, the preliminary analysis is done, and the direct relationship path coefficient is 0.123 which illustrates the positive influence and the t-statistics = 0.472 is lower than 1.6. Therefore, this direct mediating effect of TMC on PLR is not statistically significant which affirm that there is a full mediating effect of TMC on PLR through enhancing the SCRES constituents. In other words, the direct relationship between the TMC and PLR is eliminating from the PLS-SEM model 1 and the indirect mediating effect of TMC on PLS is assessed through the SCRES constituents. Besides, the moderating effect of contextual variables (INS, SEC and SIZE) on PLR is evaluated through another separate model that depicted in Figure 5.3. The moderating effect that implemented through SmartPLS software was calculated as the product of loading of moderator variable (contextual variables) and predictor variable (SCRES constituents) and the result is evaluated on PLR. The outcome of preliminary analysis shows the positive moderation effect among the SIZE and all SCRES

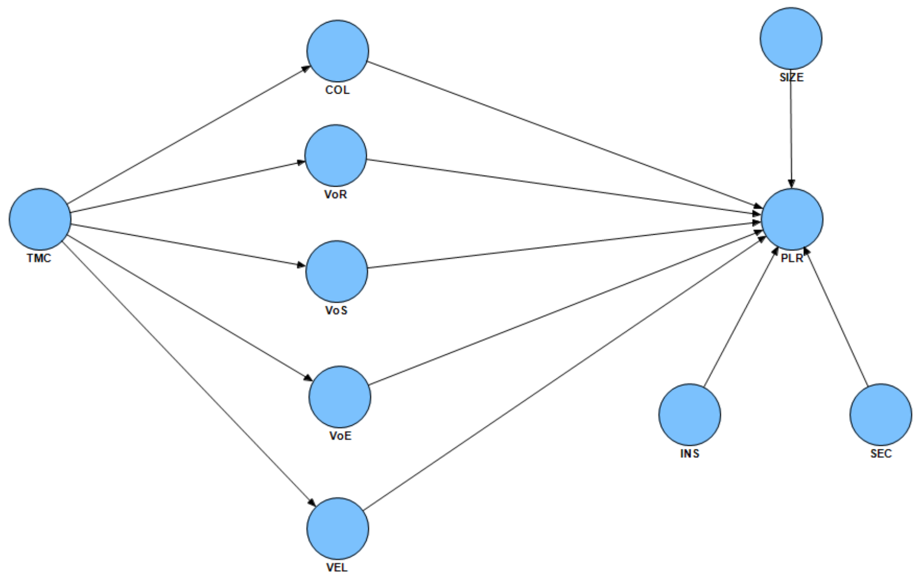

Figure 5.3: Moderating effect of contextual variables for model 1

constituents on PLR ,while the bootstrapping result confirm that none of them are statistically significant (all t-statistics are lower than 1.6). In similar manner, the result of moderation effect among SEC and SCRES on PLR depicted that, SEC is not significant variable in order to change the already existing relationship among SCRES elements and enhancing the PLR. Lastly, the importance of having the INS towards the disruption events for focal company is evaluated and the outcome depicted a positive with path coefficient equal to 0.276 and statistically significant (t-statistics=2.78). In overall, the analysis of moderation effect of contextual variables demonstrates that just the INS is statistically importance and play a key role in enhancing the PLR. In summary, all evaluated relationships which profoundly discussed before, is considered along with their level of significance in Figure 5.4.

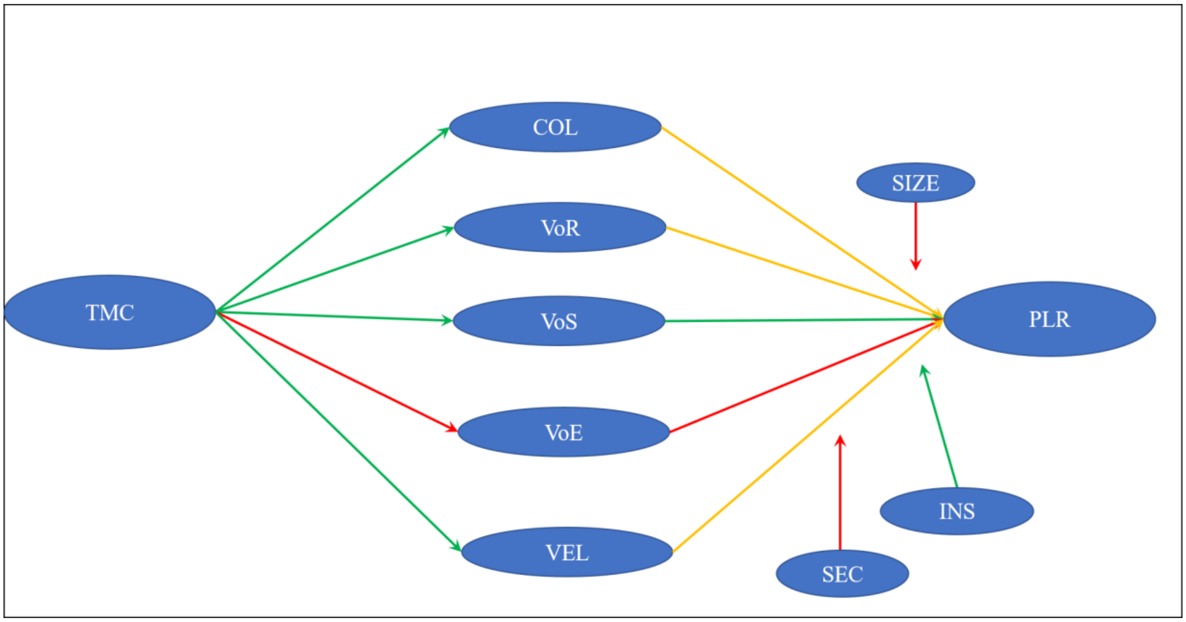

Figure 5.4: Preliminary analysis outcome of model 1

In order to better illustrates the overall outcome gained, the green arrow represent the significant relationships, the orange ones show the partially significant relationships and the red ones are depicted the non-significant relationships among variables.

5.2 Result gained from model 2

In this section the model 2 which focus on the VUR is analyzed and the relevant analysis and outcome are provided in similar procedure to previous section. The hypotheses proposed in

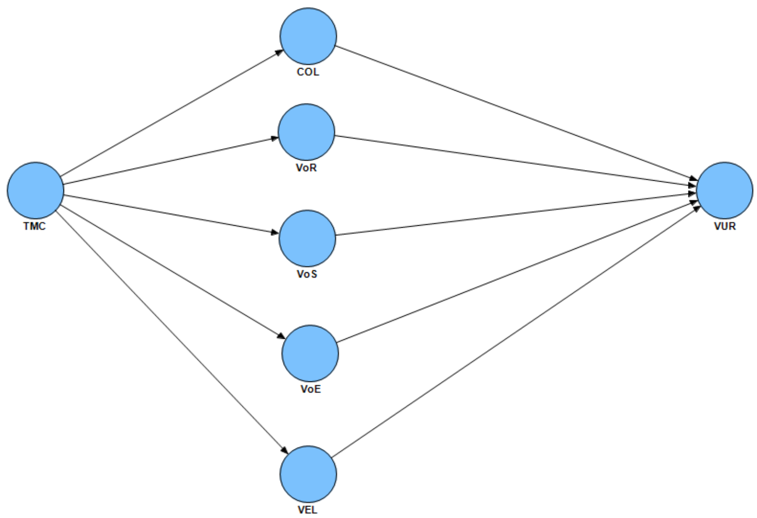

Figure 5.5：Model 2 elements and relationships

the investigation framework regarding the model 2, shown in Figure 5.5, tested by simple and multiple linear regression models, using the statistical software SmartPLS 3. The primary aim is to estimate the weight of the independent variable (VUR) on the depend variables (TMC, COL, VoR, VoS, VoE and VEL) and concerning the effect of contextual variables effect. In the first step, the basic model (without moderation and mediation effect) is created among the variables.The evaluation of the PLS-SEM results begins with an assessment of the reflective measurement model 1 and the outcome is shown based on path coefficient in Table 5.5.

Table 5.5: Path coefficient of model 2

	COL	TMC	VEL	VUR	VoE	VoR	VoS
COL	0	0	0	0.0755	0	0	0
TMC	0.8825	0	0.8127	0	0.022	0.5316	0.9452
VEL	0	0	0	0.2898	0	0	0
VUR	0	0	0	0	0	0	0
VoE	0	0	0	0.0119	0	0	0
VoR	0	0	0	0.5223	0	0	0
VoS	0	0	0	0.1324	0	0	0

Theoretically, all the provided path coefficient is positive and affirms the positive relationship among the TMC to BCM and SCRES constituents (COL, VEL, VoE, VoR and VoS) and positively influence of SCRES constituents on VUR. All the outer loadings of both exogenous and endogenous variables are evaluated and shown in Table 5.6. Furthermore, all the outer loadings are positive and above 0.70, indicating that all indicators exhibit a sufficient level of reliability (i.e.,>0.50) and affirms the suitable level of relevance among the variables and their components.

Table 5.6:Outer loadings of model 2

	COL	TMC	VEL	VUR	VoE	VoR	VoS
COL1	0.9173	0	0	0	0	0	0
COL2	0.7145	0	0	0	0	0	0
COL3	0.9128	0	0	0	0	0	0
COL4	0.8926	0	0	0	0	0	0
TMC1	0	0.9419	0	0	0	0	0
TMC2	0	0.9506	0	0	0	0	0
VEL	0	0	1	0	0	0	0
VUR1	0	0	0	0.8663	0	0	0
VUR2	0	0	0	0.8289	0	0	0
VoE	0	0	0	0	1	0	0
VoR1	0	0	0	0	0	0.976	0
VoR2	0	0	0	0	0	0.5276	0
VoS1	0	0	0	0	0	0	0.9781
VoS2	0	0	0	0	0	0	0.9687
VoS3	0	0	0	0	0	0	0.9223

In order to check the validation of model 2, the result of evaluation based on PLS-SEM model is provided in Table 5.7.

Table 5.7: Validity matrix for model 2

	AVE	Composite Reliability	R Square	Cronbachs Alpha
COL	0.7454	0.9206	0.7788	0.8853
TMC	0.8954	0.9448	0	0.8833
VEL	1	1	0.6606	1
VUR	0.7188	0.8363	0.5744	0.6098
VoE	1	1	0.0005	1
VoR	0.6155	0.7462	0.2826	0.4963
VoS	0.9152	0.97	0.8935	0.9534

Based on the AVE for the model 1, all the variables have the value higher than 0.5 that means on average the construct can capture more than 50% of the variance of its items, for instance the COL components such as COL1, COL2, COL3 and COL4 have the capability to capture the total variance of the COL. In doing so, the same explanation can be provided for the rest of variables as well. The second criteria to assess the quality of model, is the composite reliability which affirms the level of reliability of each variable. Theoretically, all the considered variables are in acceptable range of composite reliability. The third criterion is R^2 that evaluated in a similar manner in order to understand the degree of coverage of the variance of data granted by the model and based on theory explained before, all the variables have the acceptable level of R^2 (the more closer to 1, the better) except the VoE with considerably low (0.0005) that statically means this component is not remarkably capable to capture the variability of VoE (Sarstedt et al., 2017). The last criterion is Cronbach's alpha which measure of internal consistency reliability and according to explanation in previous section, the value of this element for all the variables is in category of satisfactory (between

0.7 and 0.95) and acceptable (between 0.6 and 0.7) categories (Sarstedt et al., 2017). Noticeably, in three criterions such as AVE, Composite Reliability and Cronbach's alpha for both VEL and VoE the value shown in Table 5.7 is equal to one. Mainly, those variables constructed by merely one component as VEL1 and VoE1 respectively; therefore, all the variability are explained and captured through those components. The level of significant of each coefficient in model 2 evaluated through bootstrapping with sample size of 500. In Table 5.8 the value of t-statistics is provided and based on already defined the confidence interval as 90% and its corresponding t-statistics = 1.6, the variables which are higher than 1.6 are considered as statistically significant and their effect (coefficient) must be taken into consideration in interpretation of model and its HPs.

Table 5.8: Bootstrapping result for model 2

	COL	TMC	VEL	VUR	VoE	VoR	VoS
COL	0	0	0	1.651	0	0	0
TMC	32.976	0	13.097	0	0.232	8.009	56.91
VEL	0	0	0	1.857	0	0	0
VUR	0	0	0	0	0	0	0
VoE	0	0	0	0.203	0	0	0
VoR	0	0	0	5.118	0	0	0
VoS	0	0	0	1.724	0	0	0

Based on the provided result, the conclusion could be drawn in three categories such as: highly significant, partially significant and not significant. The highly significant relationship among these variables: TMC→COL, TMC→VoR, TMC→VoS, TMC→VEL ,VoR→VUR and VEL→VUR with t-student value higher than 1.6. The partially significant relationship is among these variables: COL→VUR, VoS→VUR, with the t-student is considerably close to 1.6. Finally, the not significant relationships are considered among TMC→VoE and VoE→VUR which their t-student value is remarkably lower than 1.6. In addition to the basic model, the separate model is created to assess the mediation effect of the TMC on VUR. For this purpose, the new model is considered with the both direct relationship of TMC on VUR (TMC→VUR) and the mediation effect of TMC on VUR through the SCRES constituents (TMC→SCRES constituents→VUR) that illustrated in Figure 5.6.

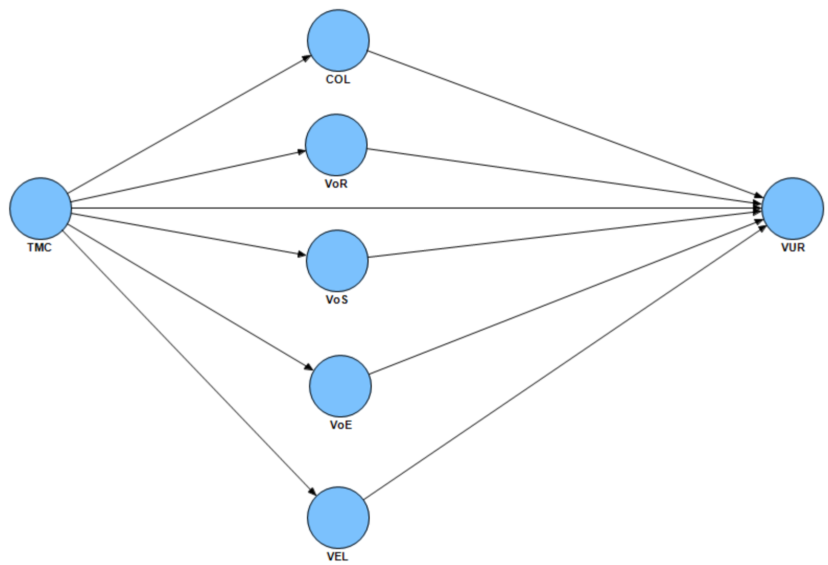

Figure 5.6: Mediation effect of TMC on VUR

Afterwards, the preliminary analysis is done, and the direct relationship path coefficient is 0.033 which illustrates the positive influence and the t-statistics = 0.127 that is lower than 1.6. Therefore, this direct moderation effect of TMC on VUR is not statistically significant which affirm that there is a full mediating effect of TMC on VUR through enhancing the SCRES constituents. In other words, the direct relationship between the TMC and VUR is eliminating from the PLS-SEM model 2 and the indirect mediating effect of TMC on VUR is assessed through the SCRES constituents. Besides, the moderating effect of contextual variables (INS, SEC and SIZE) on VUR is evaluated through another separate model that depicted in Figure 5.7. The moderating effect that implemented through SmartPLS software is based on calculating the product of moderator variable (contextual variables) and predictor variable (SCRES constituents) the result is evaluated on VUR. The outcome of preliminary analysis shows the positive moderation effect among the SIZE and VUR.

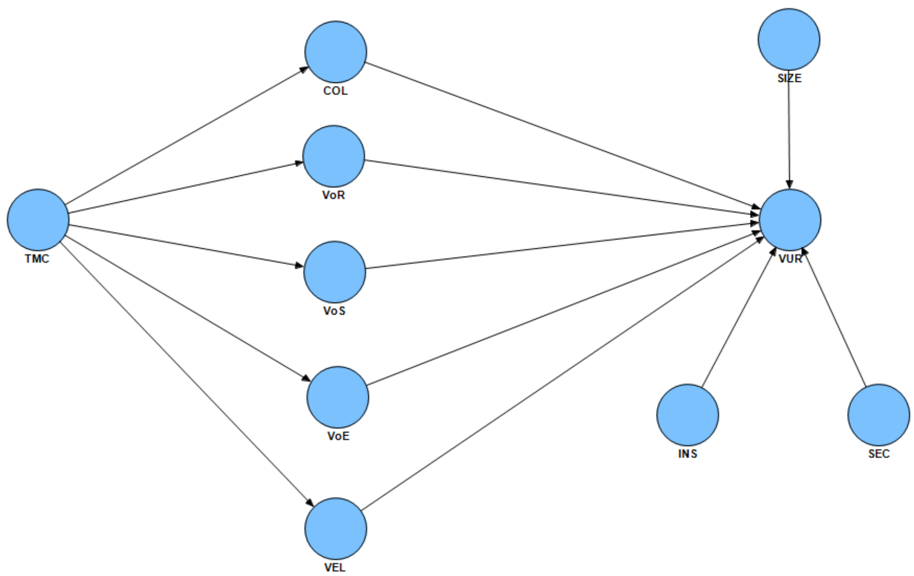

Figure 5.7: Moderating effect of contextual variables for model 2

while the bootstrapping result confirms that none of them are statistically significant (all t-statistics= 1.039 < 1.6). In similar manner, the result of moderation effect among SEC and SCRES on VUR depicted that, SEC is not significant variable in order to alter the already existing the relationship among SCRES elements and enhancing the VUR. Finally, the importance of having the INS towards the disruption events for focal company is evaluated and the outcome depicted that there is a positive with path coefficient of 0.142 and partially significant (t-statistics=1.53). In overall, the analysis of moderation effect of contextual variables demonstrates that just the INS is statistically importance and has partially influence on enhancing the PLR. In summary, all evaluated relationships which profoundly discussed before, is shown along with their level of significance in Figure 5.8.

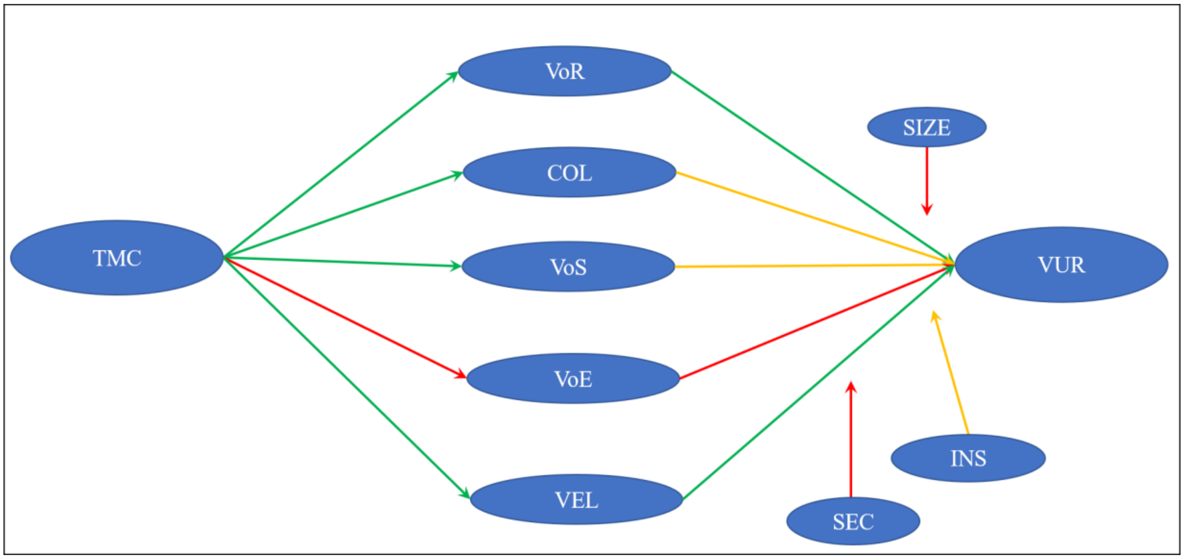

Figure 5.8: Preliminary analysis outcome of model 2

In order to better illustrate the overall outcome gained, the green arrows represent the significant relationship, the orange ones show the partially significant relationship and the red ones are depicted the non-significant relationship among variables. In summary, this chapter is mainly focused on the result of preliminary and advanced the explanation of gained outcome for both targeted variables as PLR and VUR. Apart from basic relationships among variables, two critical and fundamental types of mediation and moderation effect are proceeded for two considered models. In addition, the Table 5.9 represented the summary of PLS-SEM for former models along with their effect as significant, partially significant and non-significant ones for each one. Since the investigation of BCM influence on focal company SC performance is the core of this study, the outcome is reflected in the conceptualized matrix among BCM and SCRES. Finally, the result of the former analysis is reflected in Table 5.10 along with different level of significance relation among BCM components and SCRES constituents, the further explanation and discussion regarding the assumed HPs and how the BCM influence focal company SC performance will proceed in the next chapter.

Table 5.9: Summary of PLS-SEM models analysis

Effect		Model 1 (PLR)	Model 2 (VUR)
Basic effect	Significant	TMC→COL, TMC→VoR, TMC→VEL, TMC→VoS,VoS→PLR	TMC→COL, TMC→VoR, TMC→VEL, TMC→VoS VoR→VUR, VEL→VUR
	Partially significant	COL→PLR, VoR→PLR, VEL→ PLR	COL→VUR, VoR→PLR,
	Non-significant	TMC→VoE, VoE→PLR	TMC→VoE, VoE→VUR
Moderation effect	Significant	INS→PLR	-
	Partially significant	-	INS→VUR
	Non-significant	SIZE→PLR, SEC→PLR	SIZE→VUR, SEC→VUR
Mediation effect	Significant	TMC→PLR through SCRES constituents	TMC→VUR through SCRES constituents
	Partially significant	-	-
	Non-significant	TMC→PLR	TMC→VUR

Table 5.10: Conceptualization matrix of BCM and SCRES constituents

BCM / *SCRES*	Executive Management Commitment	Business Impact Analysis &Risk Assessment	Business Continuity Plan	Business & IT Alignment	Performance Evaluation	N questions
COL			2		2	4
VoR		1		1		2
VoE					1	1
VoS			1	1	1	3
VEL			1			1
TMC	1		1			2
VUR		2				2
PLR		2				2
						17

CHAPTER 6

DISCUSSION

This dissertation examined the influence of BCM on focal company SC performance using the SCRES as a theoretical perspective and aims at answering the following research question, as it has been already formulated and justified in Chapter 3.

- *How does BCM influence the focal company's performance in face of supply chain disruptions?*

In order to address to that question coherently, different hypotheses have been proposed and empirically examined through the implementation of PLS-SEM method. The two models focused the target variables (PLR and VUR) have been evaluated with quantitative data from the BCI supply chain resilience report 2017. Accordingly, the separate models are created in order to examine the moderation effect of contextual variables (SIZE, INS and SEC); besides the moderation effect of TMC on targeted variables. Based on these consideration and result provided in previous chapter, the HPs are discussed and explained their validation or rejection. However, the preliminary and basic statistical outcome regarding various hypotheses presented in previous chapter, the critical explanation and clarification of proposed HP, not only in terms of acceptance and rejection of them but also contribution of BCM in SC performance is considered. For the sake of clarity before discussing the different proposed hypotheses, they simply recalled.

- *HP1: Top Management leadership and commitment to BCM (TMC) has positive effect on supply chain resilience management.*
    - *HP1a: Top Management leadership and commitment to BCM (TMC) has positive effect on collaboration (COL).*
    - *HP1b: Top Management leadership and commitment to BCM (TMC) has positive effect on visibility over risk (VoR).*
    - *HP1c: Top Management leadership and commitment to BCM (TMC) has positive effect on visibility over supplier (VoS).*

- *HP1d: Top Management leadership and commitment to BCM (TMC) has positive effect on visibility over events (VoE).*
- *HP1e: Top Management leadership and commitment to BCM (TMC) has positive effect on velocity (VEL)*

The first hypothesis intended to observe direct influence TMC commitment to BCM plan on SCRES. More specifically, the influence of TMC is proposed in five sub-hypotheses that assessed TMC on each SCRES constituents. According to the ISO 22301 standard one of the absolutely key requirements of BCM implementation is the executive commitment to BCM and their support from two sides. On the one hand, TMC should have the a obvious commitment to satisfy the necessities of BCM and on the other hand , the commitment to enhance and improve the continuity plan in SC (ISO 22301 2012,). Consequently, the TMC to BCM is highly influenced the COL in a sense that managing the risk and the disruptive events should examined from the network perspective. With this regard, the TMC to BCM assured the initiation of the culture and paved the way for effectively implementation. There are different practices which assigned to COL according to questions proposed data-set , BCI supply chain resilience report 2017. For instance, the procedure which focal company assigned to check the efficiency and effectiveness and validate the level of capability of key supplier to implement BCM. In addition to that, the assurance which focal company provided to the customer regarding the sufficiency of BCM when a new business is tendering, not only highly depend on top management participation but also, their supportive commitments is facilitated the procedure in an efficient manner. The outcome of PLS-SEM model 1 confirm the a positive relation among TMC and COL and the HP1a is statistically significant and accepted. According, to the study done by on (Wieland and Wallenburg, 2013), the visibility in general view, referred as a prerequisite for better responding to hazards and risky events. Further, it enables the executive to understand about possible changes and implementation of BCM. Consequently, executive commitment to BCM is a critical factor in enhancing the visibility which leads to draw a precise overview of SC actions towards the events. According to the VoR constructs that focus more on technology for monitoring and tracking the disruption events, and TMC to BCM would create a clear atmosphere to satisfy the requirement of resilience analysis. The more, executive and business unit management are embracing the novel technology and IT infrastructure specifically in SC risk management the more VoR is concluded. Based on the discussion provided, the result of PLS-SEM confirm the positive relationship among the TMC and VoR and VoS and the two HP1b and HP1c are statically accepted. While the outcome shows that, TMC to BCM is positively affect the VoE, this effect does not have statistically significant relationship. In other word, the question allocated to VoE is more related to the recording, measuring and reporting of supplier disruption that is not extremely affected by TMC and the HP1d is not statistically significant. In doing so, the TMC to BCM, proceeded the strategy and methodologies in order to facilitates the VEL in terms of respond and recovering capabilities when the SC is affected by the disruption events (Jüttner and Maklan, 2011) and the result of analysis approved the positive influence of TMC on improving the VEL.

- *HP 2: BCM implementation positively contributes to supply chain performance loss reduction by enhancing Supply Chain Resilience constituents.*
    - *HP2a: BCM implementation enhances Collaboration (COL) which has positive effect on supply chain performance loss reduction (PLR).*
    - *HP2b: BCM implementation enhances Visibility over risk (VoR) which has positive effect on supply chain performance loss reduction (PLR).*
    - *HP2c: BCM implementation enhances Visibility over suppliers (VoS) which has positive effect on supply chain performance loss reduction (PLR).*
    - *HP2d: BCM implementation enhances Visibility over events (VoE) which has positive effect on supply chain performance loss reduction (PLR).*
    - *HP2e: BCM implementation enhances Velocity (VEL) which has positive effect on supply chain performance loss reduction (PLR).*

According to literature review and theoretical background of BCM, the ultimate consequence of BCM in field of SCM ,is ensuring the continuity of the organizations towards different type of hazardous events, which finally lead to resilience of the focal company SC performance (Rezaei Soufi et al., 2019). The field of BCM strategy and cooperation among SC players is a critical step when detrimental events are taken more attention. From strategic perspective, the BCM offers organizations an comprehensive approach by which to improve the continuity of operations in the vent of a crisis or disaster (Herbane et al., 2004b). The initial purpose of the BCM is targeting the level of preparedness and improving the capability of firms to reduce negative impact of risky events and reduce the performance losses of the

SC. Consequently, the BCM implementation provide a proper field for enhancing the capability of SC performance losses and resilience of firms under the disruptive events. In this study, this contribution of BCM proposed in HP2 and investigated through the SCRES constituents. Based on the theoretical explanation of the BCM method, it provides the possibility to manage the disruptions and their influence on SC from a network perspective and create a mutual COL and cooperative relationship among the supplier entities (Kamalahmadi and Mellat-Parast, 2016). The main advantage that BCM implementation could conduct in terms of COL is the mutual benefit achieved from collaborative working, information sharing and cooperative competences among the SC members which finally leads to have better risk management and SC performance. Beside, a more collaborative supply chain could develop and implement more effective strategies and risk management practices at supply chain level. SC performance analyzed in this study, primary considering the PLR, is positively and significantly affected by the COL that resulted from the BCM, which approved the HP2a. The visibility considered as a driver for resilience and disruption recovery phase and has a range of levels determined by the amount of useful information that is shared across the SC. In this context, the BCM implementation highlighted the need for the system that operate in a cooperative status in order to avoid (or mitigate) disruptions. Moreover, the BCM enhances the SC connectivity and information sources among the supplier which ultimately leads to SC visibility and improve the resilience and robustness of focal company's SC (Kamalahmadi and Mellat-Parast, 2016). While the conceptualization and measurement of the visibility depends on different criterion, three categorization of visibility concept are proposed through HP2b, HP2c and HP2d. According to the VoR and VoS that are relevant with two components of BCM (BIA and risk assessment), typically involves the improvement of SC resilience and performance, more specially in this study the reduction of SC losses under the disruptive events are taken into consideration. On the contrary, the result illustrated that while, there is a positive influence of VoE on PLR, this is no statistically significant. On the one hand, the allocated question to this variable, argued the measuring and recording on performance affecting SC disruption that basically, refer to some simple actions for the documentation. On the other hand, the VoE is absolutely necessary for evaluation of risk management, but not sufficient factor in order to improve the PLR when BCM is taken into account. In overall, the evaluation regarding the visibility and the outcome of PLS-SEM model regarding the effect of BCM on enhancing the VoR and

Vos, affirm the positive significant relation among them, therefore; both HP2b and HP2c are approved and HP2e is rejected. Indeed, the BCM approach can reduce the bullwhip effect and its main effect on the focal company SC performance through developing the information sharing facilities and ability to discover hazardous. In this investigation, the question that examined the concept of VEL is related to whether or not, the organizations use their own BCM when they faced with SC disruption. According this perspective, the deployment of BCM practices compared the pace of response to disturbances of organizations deployed the BCM along the SC, with those that do not have any BCM system. Evidence of incorporation regarding the improvement the VEL by BCM affect the SC performance that include the, shorting the recovering time, higher flexibility and faster reaction to the sudden changes and market requirements (Junttila, 2014; Kamalahmadi and Parast, 2016a; Montshiwa et al., 2015). In accordance with provided discussion around VEL, and result of analysis done in previous chapter, the positive and significant relationship among enhancing the PLR though VEL (which concluded from BCM implementation) is approved and HP2e is accepted. In a summary, previous critical discussion reflected the importance of BCM methodology on enhancing the PLR by conducting the theoretical perspective as SCRES constituents and in general all aforementioned hypotheses and defined relationships are assumed in model 1.

The evaluation of BCM on the vulnerability of SC is previously mentioned and proposed through the HP3 and its sub-hypotheses as below:

- *HP3: BCM implementation positively contributes to supply chain vulnerability reduction by enhancing Supply Chain Resilience constituents.*
    - *HP3a: BCM implementation enhances Collaboration (COL) which has positive effect on supply chain vulnerability reduction (VUR).*
    - *HP3b: BCM implementation enhances Visibility over risk (VoR) which has positive effect on supply chain vulnerability reduction (VUR).*
    - *HP3c: BCM implementation enhances Visibility over suppliers (VoS) which has positive effect on supply chain vulnerability reduction (VUR).*
    - *HP3d: BCM implementation enhances Visibility over events (VoE) which has positive effect on supply chain vulnerability reduction (VUR).*
    - *HP3e: BCM implementation enhances Velocity (VEL) which has positive effect on supply chain vulnerability reduction (VUR).*

The BCI supply chain resilience survey done in order to evaluate both SC continuity and SC robustness. In this section, the aim is to reveal how BCM enhance the VUR by improving the SCRES constituents. Since the BIA and risk assessment of SC, which are two key components of the BCM, is closely related to the reduction of SC vulnerability and further influenced the SCRES (Kochan and Nowicki, 2018). Further, the BCM plan caused the SC to be robust and resist disruptions, mainly remain effective in the event of disruptions. When a firms is failed to understand and proper a strategic plan towards the SC potential vulnerabilities, risks and develop a mitigation strategy, then its survival is in jeopardy (Kochan and Nowicki, 2018). Therefore, the BCM is needed to enhance the COL among the suppliers to facilitate the understanding of vulnerabilities and capabilities within the SC to diminish the negative effect of events. Further, corporate culture is necessary to mitigate the effect of a disruption through removes obstacles and embraces collaboration to take the necessary actions to recover from disruptions needs to permeate the entire SC (Zavala et al., 2019). The more a firm invest on mitigation strategies and constructive cooperation among their suppliers, the more capability gained in terms of vulnerability reduction among the SC. Thus, the positive and significant relationships among COL and VUR concluded in previous chapter, affirm this fact that the BCM plans minimize the level of susceptibility of the SC to likelihood and consequences of disruptions and the HP3a is approved. In addition, the visibility resulted from BCM implementation, positively contributed to reduction of vulnerability. The VoR actions such as measuring, tracking the disruptions and, different types of solutions which focal firm can rely on them to assess the issues that potentially affect the SC vulnerability, is an important and effective driver of VUL. The VoR is guiding the SC to propose the mitigation strategy to handle the low-likelihood high-impact risks based on analysis of SC vulnerability (Kurniawan et al., 2017). In addition, the VoR enabled the SC to take counteractive measures against the failures caused by the SC disruptions. As the statistic outcome provided the sufficient proof to support the hypothesis (significantly positive relationship among VoR and VUL), the HP3b is accepted and considers as one of fundamental influence in model 2. The VoS determine the percentage of the suppliers which have the BCM in order to address their needs; the cooperative environment extremely needs the visible over supplier in terms of operational and organizational situation (e.g. BCM and SCRES). According to the BCI supply chain resilience report 2017 and positive relations among VoS and VUR, highlighted the importance of VoS on reduction of SC vulnerability in terms of hazardous impact. Based on providing evidence, the relationship among VoS and VUL is perfectly affirmed and, therefore; the HP3c is accepted. However, most of the respondent measure and recording the performance affected SC disruptive events, this is not a significant influence on VUR. As discussed before, this insignificant relationship among the VoE and VUL is attributed to the concept and constructs of the VoE. Basically, components are some preliminary actions towards the disruptions which mainly lead to make a documentation and statistical analysis depicted that, it is not a influential effect on reduction of vulnerability (the number of disruptive events and their level of severity), while outcome of PLS-SEM analysis shows the positive effect among the VoE and VUR and the only rejected hypothesis in model 2 is HP3d. The last sub-hypothesis of this section addressed the VEL gained from BCM implementation on VUR. Due to the component that VUR constructed, the concept of pace of responding and dealing with disruption events is the BCM implementation of organization. In other words, the BCM inherently cause a considerable effect in terms of proactive and reactive characteristics of SC resilience. In this vein, prediction of SC incidents that caused detrimental events and the severity level is evaluated precisely in order to reduction the vulnerability of focal company's SC. The SC VEL goal is obtained when SC operational resilience is accomplished in a certain level of predicting, preparing and responding to risk events and achieved effectively under the BCM application. In doing so, the application of BCM that enhanced the VEL in SC, plays a critical role in promoting SC VUR improvement and contributes strategically to overall SC resilience. Hence, the positive relationship of VEL in boosting the VUR is demonstrated according to the provided discussion and the significant of this relationship was evaluated based on PLS-SEM in previous chapter; and; therefore, the HP3e is accepted. In overall, the BCM implementation drawing mitigation strategies which targeted probability and severity of risk consequences through BIA, risk analysis and performance evaluation, that is consistence with the VUR components assumed in this study.

Apart from two main models that focused on the contribution of BCM on enhancing the PLR and VUR, the effect of contextual variables are examined in separate models. In below, the proposed hypothesis and further discussion regarding their impact on targeted variables are provided.

- *HP4 (model1): Industry sector (SEC) has positive moderating effect on supply chain performance loss reduction (PLR).*
- *HP4 (model2): Industry sector (SEC) has positive moderating effect on vulnerability reduction (VUR).*

The above hypotheses are proposed the influence of SEC on target variables (PLR and VUR) to figure out the moderation effect. However, there is a positive moderating effect between SCE and both target variables, they are not statistically significant. Therefore, result gained from both models revealed that, PLR and VUR enhancement is not highly depend on different industry sector. In other words, there is no certain specification in terms of industry sectors which assume to be more vulnerable or perform better in face of disruptions.

- *HP5 (model1): Company size (SIZE) has positive moderating effect on supply chain performance loss reduction (PLR).*
- *HP5 (model2): Company size (SIZE) has positive moderating effect on supply chain vulnerability reduction (VUR).*

The contextual variable (SIZE) is constructed by, number of employees and annual revenue of organization. Based on BCI report 2017 the large organizations outperform the Small- or medium-sized enterprises (SMEs) in terms of having the BCM arrangements related to the SC (77% V.S 67%). In addition, the large organizations outpace SMEs in indicators associated with good practice (e.g. insuring for SC losses (55% V.S 40%) and high top management (44% V.S 33%)). However, the statistics provided earlier do not illustrate extremely outperforming manner for the large organizations, the SMEs have several advantages due to their size and flexibility in adopting and implementing the BCM plan. It has also been found that the SC performance of SMEs facing strong competition and tend to be more innovative and resilient (Gunasekaran et al., 2015). The outcome of PLS-SEM analysis regarding the positive but not significant effect of SZIE on PLR which determined the fact that, the BCM influence on PLR evaluation is not extremely affected by the SIZE of focal firms. In better words, the BCM plan has an influential effect on improving the performance of SC and vulnerability, regardless of SIZE. Finally, the analysis outcome add the confirmation and deeper understanding of BCM as a general plan in order to improve the PLS and VUR from the SC standpoint.

- *HP6 (model1): Insurance coverage (INS) has positive moderating effect on supply chain performance loss reduction (PLR).*
- *HP6 (model2): Insurance coverage (INS) has positive moderating effect on supply chain vulnerability reduction (VUR).*

According to BCI report 2017, the majority of respondents (51%) reported their losses were not insured, whereas, just 13% of them affirmed fully insuring towards the losses and 28% of the firms are insuring more than 50% of losses. Although, the probability of any individual adverse event may be partially negligible, the overall effect on the SC performance and their severity can be considerably huge. Therefore, INS play a key role in a) risk avoidance, with the primary objective of declining the probability of adverse events, and b) risk transferring, with the main objective to mitigate the risk of an adverse through the risk transfer to the third parties or through INS (Njegomir and Demko-Rihter, 2015). While INS is an important risk management tool for companies with complex supply chains and business continuity oriented, taking out insurance should not be seen as stand-alone solution. In other words, the INS align with the BCM program provides more capability in order to get appropriate result from vulnerability and risk strategy mitigation. In addition to indemnity, the insurer has a critical impact in providing the technical assistance to the insured in managing the financial statement and risk management to identify the frequency and level of severity of risks that threaten business continuity of firms. Therefore, The importance of INS is rely on providing the capability for organization in order to mitigate the consequence of insurable risk (e.g. financial loss) and uninsurable risk (e.g. business reputation losses) that ultimately lead to better SC performance in terms of PLR and VUR. By doing so, the proposed HP6 is consistent with above discussion in a sense that, the INS has positively significant moderation effect on PLR and VUR. Finally, based on above argumentation and concluded statistical outcome in previous chapter, the INS is considered as only influential contextual variable which positively and significantly moderate the relationship among the SCRES constituents and target variables.

Finally, the summary of hypotheses evaluation regarding both evaluated models with their components are illustrated in table below

Table 6.1: Summary of hypotheses result

Model	Effect	Hypotheses	Components	Result
Model 1	**Main**	HP1a	TMC→COL	Accepted
		HP1b	TMC→VoR	Accepted
		HP1c	TMC→VoS	Accepted
		HP1d	TMC→VoE	Rejected
		HP1e	TMC→VEL	Accepted
		HP2a	COL→PLR	Accepted
		HP2b	VoR→PLR	Accepted
		HP2c	VoS→PLR	Accepted
		HP2d	VoE→PLR	Rejected
		HP2e	VEL→PLR	Accepted
	Moderating	HP4a	SEC→PLR	Rejected
		HP5a	SIZE→PLR	Rejected
		HP6a	INS→PLR	Accepted
Model 2	**Main**	HP1a	TMC→COL	Accepted
		HP1b	TMC→VoR	Accepted
		HP1c	TMC→VoS	Accepted
		HP1d	TMC→VoE	Rejected
		HP1e	TMC→VEL	Accepted
		HP3a	COL→VUR	Accepted
		HP3b	VoR→VUR	Accepted
		HP3c	VoS→VUR	Accepted
		HP3d	VoE→ VUR	Rejected
		HP3e	VEL→ VUR	Accepted
	Moderating	HP4b	SEC→ VUR	Rejected
		HP5b	SIZE→ VUR	Rejected
		HP6b	INS→ VUR	Accepted

CHAPTER 7

CONCLUSIONS

As recently reported in the BCI Supply Chain Resilience report (2017), more than half of organizations experienced at least one supply chain disruption during one year; thus there is a need for considering and implementing approach to face environmental, financial and business related disruptions. The approaches that received lots of attention among scholars and managers in last decades are BCM and SCRES. In this dissertation the SCRES constituents was considered as the conceptual lens in order to discover how BCM influence the focal company's performance when affected by a disruption event along the supply chain. The quantitative analysis was done using a data set acquired by BCI Supply Chain Resilience report (2017), and the PLS-SEM approach with reflective constructs. Generally, the finding of this study indicated that BCM implementation helps reducing performance loss under disruption and more in general the vulnerability of the focal company to SC disruptions through improving multiple SCRES constituents.

7.1 Theoretical implications

Based on the theoretical lens of SCRES and the PLS-SEM in order to analyze the impact of BCM on PLR and VUR, we conclude that, the role of top managements is absolutely influential in order to accept the concept of BCM plan. From the organizational standpoint, the TMC to BCM is more tangible through providing a condition in order to enhance the SCRES elements such as COL, VoR, VoS and VEL; even though VoE is not significantly improved by TMC which inherently related to the unpredictable features of disruption events. To this extent, the operationalized SC performance in two categories such as PLR and VUR, shed a light on better understanding the detrimental consequences of disruptions through having specific emphasize on SC financial performance losses, frequency and severity of disruptions. With this approach, the study provide the interesting theoretical implications. First of all, the findings indicate that BCM has a profound potential and capability to improve the SC performance of focal company in terms of declining the financial losses when the disruption events are happened. In doing so, the BCM implementation was lead to enhancement of PLR of focal company's SC through SCRES elements considered in this study (COL, VoR, VoS and VEL) except VoE. Second, the findings also highlight the contribution of BCM on reduction of SC vulnerability through evaluating the frequency and level of severity of disruptions. To the best of our knowledge, the theoretical framework defined in this research is the first work which addressed the BCM and SCRES (as theoretical lens) simultaneously in conjunction with contextual variables in order to evaluate the SC performance. While the impact of BCM had been demonstrated as a significant comprehensive plan to maintain the continuity of the organization, this dissertation shed a light on influence of BCM in field of SCM. Since the BCM has been known as an integrated and comprehensive method, in the context of this study, the BCM constituents not only have a tendency in order to increase the effectiveness during the ordinary business conditions, but even also they have a great potential to addresses, how properly BCM can satisfy both proactive and reactive capability of focal company’s SC.

7.2 Practical implications

In this study, contrary to most papers dealing with the subject of business continuity, the data gained form the worldwide constitute (BCI) survey that included the SC managers which have experience in terms of proper actions, decisions and practices when their SC faced with disruptions. As shown in BCI Supply Chain Resilience Report (2017), disruptions are frequently affect the business environment and noticeably, the majority of respondents (around 70%) affirmed that they did not have full visibility of the SCs. Accordingly, the implication of BCM along with SCM, depicted that how positively BCM constituents such as BCP, BIA, technology alignment, and risk assessment tools are correlated with SCRES that ultimately facilitates the process of handling the disruptions. Thus, the awareness regarding the BCM implementation and its multifaceted effect on both continuity and resilience can be precious for proactively handling such disruptions and proposing the risk mitigation strategy by managers. Furthermore, the findings of this research underscore how BCM improve the SCRES capability, which has mitigation power on detrimental consequences of disruptions, lead to better achievement of SC performance. More specially, mutual collaboration with suppliers, SC risk management and SC visibility can help managers in counteracting the disruptive events and creates proper condition for them to shape their continuity and resilient approach. Finally, it is of relevance for SC managers to understand the attributes of BCM as comprehensive and integrative concept which has excellent potential for conducting along with SCM in order to better mitigate the effect of SC disruptions.

7.3 Limitation and further work

As with all research, this study has some limitations that need to be acknowledge. First of all, the limitation arise from the already designed questionnaire by BCI Supply Chain Resilience Report (2017) which is assumed as the main obstacle in this study. While the BCI survey, mainly targeted two sections as a) supply chain disruptions and b) supply chain resilience and business continuity, there is lack of capturing ability in order to define our reflective variables. In doing so, each question of BCI survey is allocated to relevant considered variables (COL, VEL and etc.) according to the level of relevance and consistency among each other. Therefore, considered variables may not completely captured the concept and different aspect of each SCRES constituents since some of defined elements such as VoE and VoS are constructed by merely one allocated question. Second, in our proposed theoretical framework we just analyzed one mediator variable as an indirect relationship of TMC on PLR and VUR; further analysis is needed to include other moderator such as SC complexity in evaluation of SC performance. Third, other constituents of SCRES such as flexibility and redundancy which are assumed as an important factors of SCRES (Kamalahmadi and Parast, 2016a) are not considered in this dissertation due to the fact that, the BCI survey questioner is not designed based on SCRES constituents by ourselves. Therefore; the study of BCM contribution on SC performance with addressing all SCRES constituents is really needed. Furthermore, this study reveals some avenues for future research in field of BCM as well as SCRES. First, the design questionnaire based on all SCRES and BCM constituents, will conceptualized the meaning of each element in a more accurate and precise manner. Since data set considered in this study was constrained by already designed questionnaire, the generalizability of findings may not be advisable. Indeed, other potential tools that companies can apply to become more resilient (Tukamuhabwa Rwakira, 2015b) can be considered as a theoretical lens and explore how BCM could deployed in order to boost the SC performance. Second, the influence of BCM maturity model could be further explored by researchers in order to contribute the desirable level of BCM maturity and enactment of SC performance as well as resilience capability of focal firm. Finally, there is room for the relevant qualitative tools such as interviews or focus group discussions with SC managers to explore the further explanation regarding unsupported hypotheses.

CHAPTER 8

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