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DEPARTMENT OF BUSINESS ADMINISTRATION
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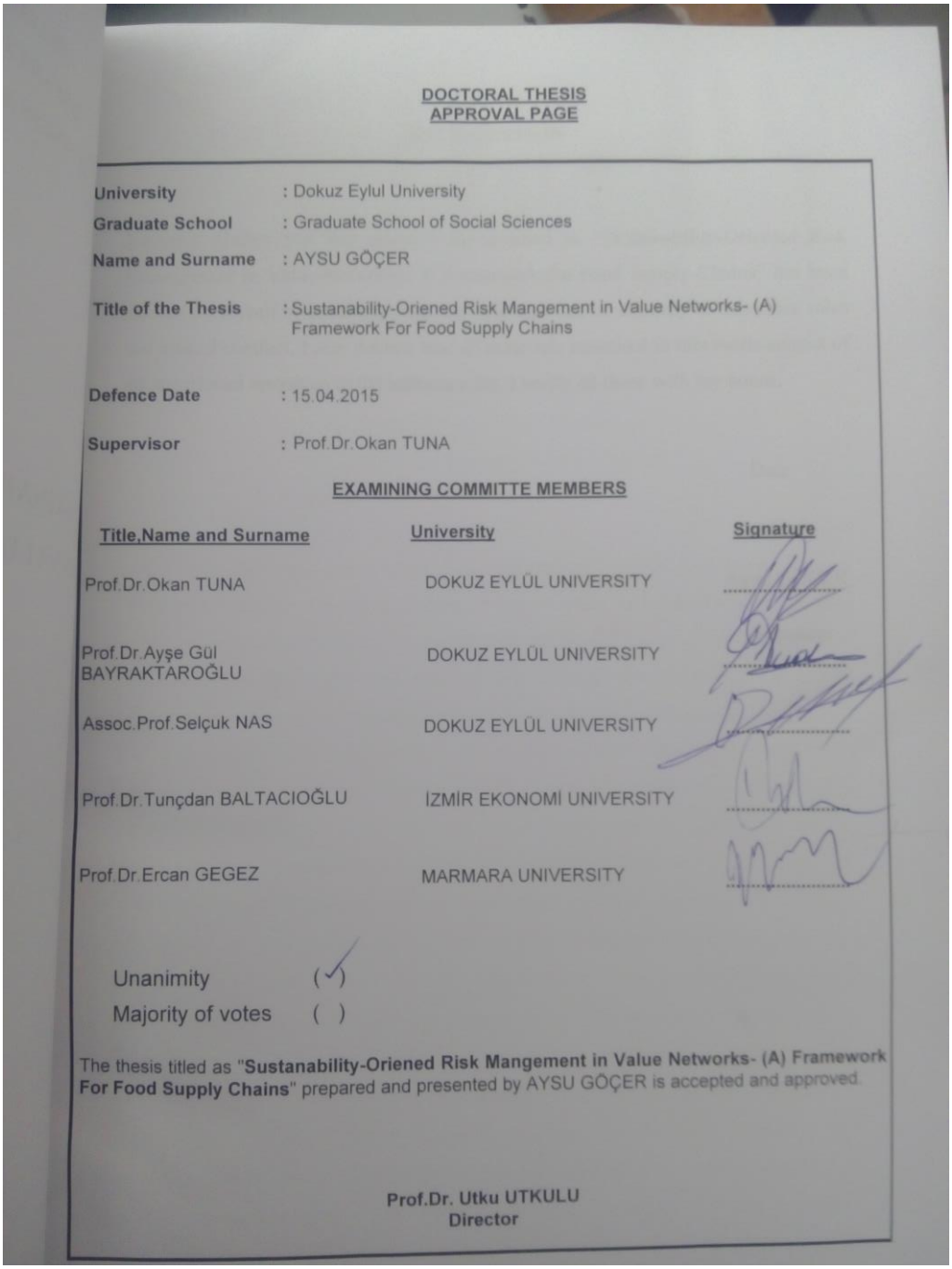
DOCTORAL THESIS
Doctor of Philosophy (PhD)

SUSTAINABILITY-ORIENTED RISK MANAGEMENT IN VALUE NETWORKS – A FRAMEWORK FOR FOOD SUPPLY CHAINS

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DECLARATION

I hereby declare that this doctoral thesis titled as "Sustainability-Oriented Risk Management in Value-Networks: A Framework for Food Supply Chains" has been written by myself without applying the help that can be contrary to academic rules and ethical conduct. I also declare that all materials benefited in this thesis consist of the mentioned resources in the reference list. I verify all these with my honor.

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ABSTRACT

Doctoral Thesis

Doctor of Philosophy (PhD)

Sustainability-Oriented Risk Management in Value-Networks: A Framework for Food Supply Chains

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Graduate School of Social Sciences

Department of Business Administration

Business Administration PhD Program

The enormous complexity and uncertainty surrounding supply chains increasingly trigger efforts to ensure competitiveness and survival in the global arena. Especially, serious losses caused by social, ecological and ethical problems have raised attention towards new areas of competitiveness related to avoiding risks in all dimensions of sustainability (environmental, social and economic). Despite this, research is still scarce on risks related to sustainability issues, especially from an industry-specific focus. In this thesis, it is aimed to develop a sustainability framework on supply chain risk management strategies, and propose an approach to assessing sustainability orientation.

The theoretical methodology is designed within the framework provided by theory of constraints and chaos theory. Multiple methodologies were employed to explore and explain the risk factors in sustainability framework. Risk factors were identified from sustainability framework through multiple-case study in food supply chains, specifically in animal-food products, and coded through content analysis. The results were analyzed within each case, as well as cross the cases. The conceptual model of the study was outlined, and relative importance of risk factors was evaluated in terms of their impacts on economic, environmental and social sustainability-related hazards by fuzzy AHP in order to develop an integrated approach to different sustainability dimensions.

The results indicated that sustainability-oriented food supply chain risk management requires the urgent avoidance of behavioral risk factors by all related supply chain members, with specific attention on the consciousness factor. This thesis study provides insights to academicians on extending different theoretical lenses towards sustainability in relation to risk, and a path for practitioners in incorporating sustainability framework into supply chain risk management strategies.

Keywords: Value Network, Supply Chain, Logistics, Sustainability, Risk, Animal-Food

ÖZET

Doktora Tezi

Değer Zincirlerinde Sürdürülebilirlik Yönlü Risk Yönetimi – Yiyecek Tedarik Zincirleri için Bir Çerçeve

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Küresel ortamda rekabetçiliğin ve varlıklarını sürdürebilme mücadelesinin sağlanması için harcanan çabalar, tedarik zincirlerini çevreleyen muazzam karmaşa ve belirsizlik ile artarak tetiklenmektedir. Özellikle, sosyal, çevreyle ilgili ve ahlaki bir takım problemler sonucu yaşanan büyük kayıplar, rekabetiçiliğin sağlanması için sürdürülebilirliğin her üç boyutunda da (çevresel, sosyal, ekonomik) risklerin önlenmesi yönünde yeni alanlara dikkat çekmeye başlamıştır. Buna rağmen, sürdürülebilirlik ile ilgili riskler üzerine, özellikle de sektörel açıdan yapılan araştırmalar, hala oldukça azdır. Bu tezde, tedarik zinciri risk yönetim stratejilerine sürdürülebilirlik çerçevesinin geliştirilmesi ve sürdürülebilirlik yönelimlerinin değerlendirildiği bir yaklaşım önerilmesi amaçlanmaktadır.

Kuramsal yöntem, kısıtlar teorisi ve kaos teorisi çerçevesinde tasarlanmıştır. Risk etkenlerini sürdürülebilirlik çerçevesinden araştırmak ve açıklamak için çoklu yöntemler uygulanmıştır. Risk etkenleri, yiyecek tedarik zincirlerinde, hayvansal ürünler özelinde uygulanan çoklu vaka analizi ile sürdürülebilirlik çerçevesinden belirlenmiş ve içerik analizi ile kodlanmıştır. Bulgular, her bir vaka için kendi içinde ve vakalar arası karşılaştırmalı olarak analiz edilmiştir. Çalışmanın kavramsal modeli şemalandırılmış ve risk etkenlerinin göreceli önemi, farklı sürdürülebilirlik boyutlarına bütünleşik bir yaklaşım geliştirebilmek için, ekonomik, çevresel ve sosyal sürdürülebilirlik ile

ilgili tehlikelere olan etkileri açısından bulanık AHP yöntemi ile değerlendirilmiştir.

Sonuçlar, yiyecek tedarik zincirlerinde sürüdürülebilirlik yönelimli risk yönetimi için davranışsal risk etkenlerinin, özellikle bilinç etkeni açısından, tüm ilgili üyeler arasında ivedi olarak önlenmesinin gerekliliğini ortaya koymuştur. Bu tez çalışması, akademisyenlerin risk ile ilgili sürdürülebilirlik konularına farklı kuramsal bakış açısı geliştirmelerine olanak tanıyacak ve uygulamacıların tedarik zinciri risk yönetim stratejilerine sürdürülebilirlik çerçevesi geliştirebilmelerinde bir yol gösterecektir.

Anahtar Kelimeler: Değer Zinciri, Tedarik Zinciri, Lojistik, Sürdürülebilirlik, Risk, Hayvansal Yiyecek

SUSTAINABILITY-ORIENTED RISK MANAGEMENT IN VALUE NETWORKS – A FRAMEWORK FOR FOOD SUPPLY CHAINS

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ABBREVIATIONS

5FS	Five Focusing Steps
AHP	Analytical Hierarchy Process
ANP	Analytic Network Process
CFCS	Converting Fuzzy Data into Crisp Scores
CI	Consistency Index
CR	Consistency Ratio
CSCMP	Council of Supply Chain Management Professionals
DOCAS	Dynamic Open Complex Adaptive Systems
EU	European Union
FAO/WHO	Food and Agriculture Organization of the United Nations and the World Health Organization
FIFO	First-In First-Out
FMCEA	Failure Mode, Effects and Criticality Analysis
FSA	Food Safety Association
GPS	Global Positioning System
HAZOP	Hazard and Operability Analysis
ISM	Interpretive Structural Modeling
JIT	Just-in-Time
KPI	Key Performance Indicators
MCDM	Multi-Criterion Decision-Making
MICMAC	Matrice d'Impacts Croises Multiplication Appliquee a un Classement
MRP	Material Requirements Planning
MRPI	Material Requirements Planning I
MRPII	Material Requirements Planning II
NASA	National Aeronautics and Space Administration
OPT	Optimized Production Technology
QC	Quality Control
R&D	Research and Development

RF	Risk Factor
RI	Random Index
SC	Supply Chain
SEM	Structural Equation Modeling
SSIM	Structural Self-Interaction Matrix
TBL	Triple-Bottom-Line
TFN	Triangular Fuzzy Numbers
TOC	Theory of Constraints
UK	United Kingdom
WCED	World Commission on the Environment and Development

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CHAPTER I
INTRODUCTION

The increasingly complicated global business environment has moved the focus of companies towards value-creating activities, with the key aim of achieving superior customer value. This requires the attention on value-creating networks from the perspective of marketing concept in order to achieve organizational goals, which emphasizes the importance of delivering the desired level of satisfaction to the customer needs and wants in the target markets better than the competitors' (Kotler and Armstrong, 1994). Accordingly, the agenda of marketing has been evolving in parallel to the changing requirements and expectations of the customers, with the aim of gaining a competitive advantage in the market. Therefore, the early twentieth century's product-oriented focus of marketing has shifted towards a customer oriented view, and the increased efforts are now spend to stay competitive in the eyes of the customers.

The eras in marketing progressed through five main concepts, related to production, product, selling, marketing, and societal marketing (Kumar et al., 2012). Following this revolution, the field of marketing has undergone many changes with the adaptation of different marketing strategies. In the mid to late twentieth century, societal marketing adopted a consumer centric approach, targeting the creation of superior value to the customers, which raised social and ethical concerns in the agenda of marketing activities. This evolution is now in its stage with sustainability criteria to be incorporated into marketing concept as an obligatory requirement to ensure competitive advantage, rather than as an option (Charter et al., 2006). This new concept of marketing concerns for fulfilling not only today's personal needs and wants, but also for future generations, by providing sustainability based value to the customers, through the integration of environmental and social value-creating efforts to economic efforts. This approach is necessarily recognized by the companies, with serious losses caused by social or environmental problems (Hoffmann et al., 2013). Therefore, the evolving trend of marketing related to sustainability-based value creation involves the avoidance of social, environmental and economic losses for

future generations (Krysiak, 2009), in order achieve superior customer value, and to ensure desired levels of satisfaction.

Value-creating networks, formed by the companies that come together and link their core competencies, can also be labeled as supply chains, with members embedded through the value propositions to create superior value for the markets and their customers (Kothandaraman and Wilson, 2001; Lusch, Vargo and Tanniru, 2010). Therefore, sustainability related losses, which might have been caused by the growing complexity of global networks, are also serious issues to be considered by the supply chains for achieving sustainable development (Gladwin, Kennelly and Krause, 1995).

1.1. INTRODUCTION TO THE RESEARCH PROBLEM AND AIMS OF THE STUDY

Supply chains, as sub-part of value networks, are essentially a part of global operational arena of enormous complexity and uncertainty. This has increased the concerns of supply chains for competitiveness or survival in this arena, and forced supply chains to more effectively manage these geographically dispersed, complicated flows of operations. This has raised new dimensions of competitiveness related to risk-oriented strategy development and sustainability in supply chains. The risk-oriented strategy development is necessarily important in supply chain wide context, in order to reduce the vulnerability of the entire chain (Rao and Goldsby, 2009). Thus, supply chain risk management is the process of decision-making, involving evaluating risks and adopting an appropriate solution which minimizes its negative influence and reduces its probability (Rajabinasr et al., 2013) through coordination and collaboration to ensure profitability and business continuity (Tang, 2006). On the other hand, sustainability refers to the close consideration, even the integration of social, environmental, and economic dimensions. The idea of this three dimensioned integrated framework on sustainability is defined by Carter and Rogers (2008: 368) as “the strategic, transparent integration and achievement of an organization’s social, environmental, and economic goals in the systemic coordination of key inter-organizational business processes for improving the long-

term economic performance of the individual company and its supply chains". Sustainability is an approach also to be considered while developing risk management strategies. It is now argued that avoiding risk in all three dimensions of sustainability is critically important (Seuring and Müller, 2008). Considering this, sustainability risk is regarded as a new and critical emerging area of risk (Seuring and Müller, 2008; Anderson and Anderson, 2009).

Despite its importance, sustainability issues are largely neglected in supply chain risk management studies. The framework on risks related particularly to sustainability issues are in a minority (Hoffmann et al., 2013). However, it is now evident that social, ecological and ethical problems result in serious losses for firms and their supply chains (Hoffmann et al., 2013).

Besides, many of the studies prefer to focus on individual manufacturer rather than the supply chain, and therefore fail to collect and present dyadic data. The measures are not defined after a complete span across supply chain partners, and thus are not well applicable in a supply chain context (Hassini, Surti and Searcy, 2012).

In addition to the increasing need for a focus of research on sustainability in relation to risk on a supply chain wide scope, it has become well-recognized that supply chain risks and risk management strategies as well as sustainability practices cannot be effective across diversified industrial sectors, and are likely to vary with the nature, size and type of industry (Jüttner, 2005; Cleland, D.J., 2010; Olson and Wu, 2010; Rajurkar and Jain, 2011; Singhal, Agarwal and Mittal, 2011; Zanoni and Zavanella, 2012; Wen and Ouyang, 2013). Besides, industry-specific research especially on sustainable supply chain management requires more attention in studies (Carter and Easton, 2011; Hassini, Surti and Searcy, 2012). When considered from this industry-specific framework, it is now evident that sustainability is becoming a key concern for industries including automotive, electronics, textile and food industries (Koplin, Seuring and Mesterharm, 2007; Seuring and Müller, 2008; Seuring et al., 2008; Cleland, D.J., 2010; Zanoni and Zavanella, 2012). Especially, for the food industry, additional concerns are cold chain sustainability issues, i.e. the low-temperature logistics system with refrigerated storage and different packaging and process requirements (Cleland, D.J., 2010; Zanoni and Zavanella, 2012; Wen and Ouyang, 2013). The basic difference between food supply chains and others

involves the important concern of a continuous change in the quality of raw materials during the logistics processes until the products reach the consumers (Rajurkar and Jain, 2011), and thus different risks arise, such as contamination, biological risks, genetic risks and natural disasters (Singhal, Agarwal, and Mittal, 2011). Cold chains are also referred as temperature-controlled supply chains working with low-temperature logistics systems which require equipment and processes to keep perishable products within a conditioned environment. Therefore, logistics is the key to the cold chain (Zanoni and Zavanella, 2012; Manzini and Accorsi, 2013; Wen and Ouyang, 2013). This significance has become evident with food incidents and scandals of recent years, which resulted in loss of consumer trust and confidence in food safety. Therefore, it is now necessarily important to regain and retain consumer trust by providing information on the safety and identity of their food (Wognum et al., 2011). This highlights the importance of involving consumers in the focus of food risk management studies, rather than stopping at retailers (Houghton et al., 2008). Thus, the consideration of insights of the consumers, especially on food safety perceptions, is critically important for creating value (Olsson and Skjöldebrand, 2008).

Within this perspective, the aim of the study is outlined as;

- to develop a sustainability framework on supply chain risk management strategies,
- to propose an approach to assess the sustainability orientation in supply chain risk management strategies.

Considering the negligence in the literature, the research focus is identified as being industry-specific for food industry logistics operations, with an emphasis on cold chain activities, and unit of analysis is defined as the supply chain; that is, the food supply chain for animal-products. Multiple methodologies are used to explore and explain the constructs, including both qualitative and quantitative approaches.

Based on the major aims of the study, the theoretical focus of the study is built on the literature related to three main areas; supply chains, risk management and sustainability, with a specific focus on food supply chains. An extensive

literature review is conducted within the scope of these areas; from which reference information is outlined and utilized at each stage of the research process.

A multiple-case study is conducted with five types of food supply chains, each of which includes cold logistics activities in their scope. Risk factors are explored through multiple case study research, in which data is collected through observations at multiple sites and through semi-structured interviews of several managers at different supply chain levels as well as the consumers.

As this study is designed as a multiple-case study, in which semi-structured interviews and observations are conducted in different supply chains, a moderate constructivist approach is followed, which is an accepted alternative perspective to critical realism in case studies (Järvensivu and Törnroos, 2010), in line with the idea that truth is community-based (community as being both research subjects and the researchers). In addition, in this study, it is considered extremely important to review different viewpoints from a variety of supply chain members in different food chain industries, rather than seek a single reason or the truth. Therefore, this study extends beyond triangulation, moving closer to crystallization, which is the central metaphor for validity in constructionist research (Richardson, 2000; Tracy, 2010). Furthermore, both inductive and deductive design of the study orients the research towards an abductive approach (Järvensivu and Törnroos, 2010).

Findings of multiple-case study are analyzed and coded through latent content analysis. Besides, in order to identify whether the risk factors coded in the multiple-case study were identified in previous studies, and if so, with which frequency, a manifest content analysis was conducted by the computer software NVivo. The article search was conducted basically in *web of knowledge* database. Web of knowledge was selected as the reference database as it is one of the most credible databases in academy. In this way, the code of each risk factor was verified, and revised if necessary. Based on the findings, within case analysis, presenting the findings in each individual case, and cross case analysis, presenting the similarities as well as differences across case studies are reported. The contextual relationships and interrelations of those risk factors were then modeled through interpretive structural modeling (ISM) methodology. Risk factors were then evaluated in terms of their impacts on sustainability-related hazards by fuzzy analythical hierarchy process

(AHP) methodology. All three dimensions, namely social, environmental and economic, were considered while assessing these risk factors. The findings contribute to the presentation of sustainability-oriented supply chain risk management approach developed in this study, and theoretical as well as practical implications are reported accordingly.

While the theoretical focus of the study is outlined, an approach for revealing supply chain risk factors from related theories is proposed. Considering the gap in the literature, highlighting that research focusing on risk identification is still in an early stage (Rao and Goldsby, 2009), this approach would both provide a framework for identifying generic supply chain risks from a theoretical perspective, and help researchers as well as practitioners identify the root causes of risks inherent in supply chain activities.

1.2. THEORETICAL FOUNDATIONS OF THE STUDY

Various theories are addressed to explain the issues related to supply chain, risk and sustainability areas in the literature. Having reviewed the assumptions of related theories, the theoretical background of the study is grounded on theory of constraints (TOC) and chaos theory. TOC is a philosophy of continuous improvement and primarily developed by Eli Goldratt (Goldratt and Cox, 1984). In TOC, it is highlighted that every business has at least one constraint and constraints determine the performance of a system. Any organization's performance is limited by its weakest link or system constraint and the overall goal is to strengthen the weakest link (Cox and Schleier, 2010). On the other hand, Goldratt and Cox's theory of constraint understanding also supports the framework provided by chaos theory, invalidating the reductionist view and arguing that the sum of the local optimums is not equal to the global optimum (Wilding, 1998). Chaos theory is basically an evolutionary system theory. An important assumption of chaos theory is that the system is a set of parts interacting with each other while functioning as a unified whole, and thus, small changes in initial stages of this system can amplify exponentially and greatly impact the pattern of the system's growth and evolution. This sensitivity to initial conditions is also known as the butterfly effect (Wilding,

1998), and also reflects the idea of potential chaos which can be created in food chains by a minor error in the initial stages.

Therefore, this study is designed within the framework provided by TOC and chaos theory to better present the approach in developing sustainability-oriented supply chain risk management. The main concepts of TOC have been adopted and re-defined in a risk and sustainability framework with a Triple-Bottom-Line (TBL) approach, including constraint, goal, drum-buffer-rope, evaporating cloud, three questions of TOC and five focusing steps (5FS). Therefore, this study can be considered an attempt to provide an extended framework to TOC, by revising the propositions associated by the assumptions of chaos theory, in order to develop a sustainability orientation on risk management.

1.3. RESEARCH QUESTIONS OF THE STUDY

Defining research questions a priori would provide a path for specifying the kind of samples to be approached as well as the kind of data to be gathered (Eisenhardt, 1989).

Therefore, considering the research problem and major aims of the study, research questions are identified as follows:

RQ1: How can supply chain risk factors be identified generically?
RQ2: What are the risk factors in the logistics operations of food supply chains from a TBL perspective (environmental, social and economic)?
RQ3: What are the risk factors addressed at each type of food supply chain?
RQ4: How do the risk factors differ across food supply chain types?
RQ5: What are the contextual relationships and interactions across risk factors in food supply chains?
RQ6: Do the relative importance of risk factors in logistics operations of food supply chains differ in terms of their impacts on economic, environmental and social sustainability-related hazards?
RQ7: How can sustainability-oriented food supply chain risk management developed?

1.4. SIGNIFICANCE OF THE STUDY

Although risk management is widely studied in the supply chain management literature, studies focusing on supply chain risks with sustainability framework are in minority (Hoffmann et al., 2013). However, the sensitivity towards sustainability and risk relation is increasing, and there is growing acceptance of the critical necessity for supply chains to ensure sustainability at all stages of their business activities, and integrate sustainability concerns in their risk management programs (Knoepfel, 2001; Azapagic, 2003; Wolf, 2011; Hoffmann et al., 2013). It is now argued that avoiding risk in all three dimensions of sustainability is critically important (Seuring and Müller, 2008). Therefore, the major significance of this study lies in its fundamental context, which aims to address this gap by developing a sustainability orientation to risk management strategies of supply chains, considering all three dimensions of sustainability.

Another significance of the study is related to its unit of analysis, i.e. focuses on the supply chain, rather than an individual manufacturer (Carter and Easton, 2011; Hassini, Surti and Searcy, 2012). Multiple-case study was conducted, with each single case as being *supply chain* as the basic unit of analysis, and dyadic data across cases was collected accordingly. Thus, data from various levels of different supply chain types allows a deeper insight and more comprehensive understanding on the issues under consideration.

Besides, the industry-specific design of the study addresses another gap in the literature, in which the academic attention required on sustainability (Carter and Easton, 2011; Hassini, Surti and Searcy, 2012) and risk management (Jüttner, 2005; Olson and Wu, 2010; Singhal, Agarwal and Mittal, 2011) was highlighted.

Furthermore, multiple methodologies utilized, including both qualitative and quantitative approaches, strengthened the arguments provided by the study. Multiple-case study, in which data was collected through semi-structured interviews and observations, has been coded through latent content analysis to identify risk factors. The outlined risk factors were assessed and verified through manifest content analysis by the computer software programming NVivo. This analysis was then reported in the form of within and cross case analysis. Moreover, ISM approach was

utilized to outline the contextual relationships and interrelations amongst those risk factors. Later, sustainability orientation was developed on those risk factors through prioritization by fuzzy AHP with respect to environmental, economic and social dimensions distinctively. The rich methodological path followed in the study strengthened the arguments, and supported the development of the complete framework addressing the major aims and research questions of the study. The discussions generated in different phases of the methodology contribute in various aspects to both the literature and the industry. The analysis employed by Fuzzy AHP can also be considered as a contribution to the fuzzy AHP literature, which is added to the sustainability area by this methodological approach, in terms of integrating its different TBL dimensions.

This study follows a moderate constructivist approach with an abductive reasoning (Järvensivu and Törnroos, 2010). In moderate constructivism, the existence of a universal truth is rejected, and the main concern is on the possibility of community-based knowledge (Jarvensivu and Törnroos, 2010). In case studies, this approach is considered to be an accepted alternative perspective to critical realism (Järvensivu and Törnroos, 2010). Besides, through abductive reasoning, the inductive and deductive approaches are combined in order to develop a richer understanding on the issue (Kovács and Spens, 2007; Jarvensivu and Törnroos, 2010). Based on this approach, rather than aiming to seek a single version of the truth, multiple-case study was conducted in this research to outline and consider viewpoints of different supply chain members from different levels and different food supply chain types, through interviews and observations at various sites. The major findings of the study were then evaluated through mixed methodologies of both qualitative and quantitative approaches. Therefore, this study can be considered to be moving beyond triangulation, and extending towards crystallization (Richardson, 2000; Tracy, 2010).

In total, forty one semi-structured interviews (ten of which are with consumers) were conducted face-to-face with different supply chain members at thirty two companies (including farms, manufacturers, logistics service providers, distributors, dealers, retailers, grocery stores, food markets, restaurants, consumers…etc.) from different levels and different food chain types (e.g. dairy

supply chain, meat supply chain, chicken supply chain, fish supply chain, retail supply chain). Besides, observations were conducted at twenty eight sites, including milk farms, fish farms, meat production centers, food markets, food safety association (FSA) meetings…etc. and transcripts of approximately twenty hours of interview records were supplemented with the insights gained from the site visits and observation notes. The large sample size, and voluminous data provided by this study also importantly contribute to the research findings, and underline the significance and quality of the study.

Furthermore, prominence is given to the role of the perceptions of the consumer in this study, especially on food management issues, in line with the literature (Houghton et al., 2006; Houghton et al., 2008; Olsson and Skjöldebrand, 2008; Von Kanel et al., 2010). This consideration of the consumers in the research process is primarily due to the fact that consumers are also acknowledged as important members of supply chains as well as the fact that the insights provided by the perceptions of the consumers are necessarily important for creating value (Olsson and Skjöldebrand, 2008). Therefore, multiple-case study conducted in this study amongst several food supply chain members includes the consumers for outlining the risk factors leading to sustainability hazards, and provides a comprehensive, broader and deeper understanding on the issues discussed. Thus, the rich context of the study will contribute to the marketing literature by acknowledging the involvement of consumers in strategy development process of value networks.

On the other hand, another significance of the study is its rich theoretical context. Several theories were utilized at different stages of the study, and unique propositions were outlined as a result of the discussions. First, in this study, an innovative approach presented, which propose to reveal supply chain risk factors from existing theories. Ten theories identified within the theoretical focus of this study were reviewed, and their fundamental assumptions were discussed. From these discussions, risk factors inherent in those theories were outlined, which then was proposed as generic supply chain risk factors. This proposed approach would both provide a framework for identifying generic supply chain risks from a theoretical perspective, and also help researchers, as well as practitioners identify the root causes of risks inherent in supply chain activities by utilizing existing theories.

Second, the theoretical foundation of this study was derived from the assumptions provided by TOC and chaos theory. The main concepts and propositions provided by TOC were revised based on a sustainability-oriented risk management framework. Therefore, this study could be considered as an attempt to extend the framework provided by the TOC, as its propositions were revised and associated by the assumptions of chaos theory for developing a sustainability orientation on risk management.

1.5. STRUCTURE OF THE THESIS

This paper is structured in six chapters. Theoretical focus of the study is presented in **Chapter 2**, which provides an extensive literature review on supply chains, risk management and sustainability from a marketing perspective with a specific focus on value networks.

In **Chapter 3**, the theoretical foundations of the study are discussed based on TOC associated with chaos theory, and the theoretical framework of the research is presented. On the basis of this framework, the concepts and propositions of TOC are extended in accordance with the major aim of the study; the development of a sustainability-oriented risk management framework. Subsequently, in this chapter, first research question is addressed, in which an approach for identifying supply chain risks generically from the perspectives of different theories related to supply chain, logistics, sustainability and risk management is presented; these theories include agency theory, contingency theory, dynamic capabilities, institutional theory, natural resource based view, population ecology, resource based view, resource dependence theory, stakeholder theory and transaction cost economics. The theoretical model of the study is extended within the framework provided by the generic risk factors outlined from the theories.

Chapter 4 includes the methodologies followed throughout the research process, as well as the sampling methods and characteristics of the samples. In addition, the literature of food supply chains in relation to the theoretical focus is discussed. Besides, quality of the study is highlighted in this chapter through discussions on validity and reliability.

In **Chapter 5**, the findings of the study are presented and discussed, which address the second, third, fourth, fifth, sixth and seventh research questions of the study. First, the latent content analysis of the multiple-case study, as well as the part where the verification of the latent codes are done by manifest content analysis through an article search on web of knowledge by NVivo software, are presented in detail. Besides, within and cross case analysis outlined by the multiple-case study are presented. In this chapter, the conceptual model of the research findings is developed. Finally, arguments are given for the need to prioritize risk factors based on their impacts on environmental, social and economic hazards by fuzzy AHP, in order to propose a sustainability framework in risk management strategies in supply chains.

Finally, the results are discussed in terms of their contribution to theory and practice in **Chapter 6**. This is followed by the discussions on the limitations of the study and recommendations for further research.

CHAPTER II
RISK MANAGEMENT AND SUSTAINABILITY IN VALUE NETWORKS

The theoretical focus of the study is based on the marketing literature, which focuses on value creating activities in the context of networks. Value-creating networks are also labeled as supply chains (Kothandaraman and Wilson, 2001; Lusch, Vargo and Tanniru, 2010) with upstream and downstream members, which work together to create customer value (Kothandaraman and Wilson, 2001). In their effort, supply chains nested with multiple value networks (Lusch, Vargo and Tanniru, 2010), necessarily go beyond their local boundaries, and are dispersed all around the globe, and are surrounded with increased uncertainty and complexity. This has introduced new challenges and triggered other environmental and social problems associated with different stakeholders, which necessitated risk management to be considered from the framework of sustainability, and inevitably made an integral part of a holistic supply chain framework (Christopher and Lee, 2004; Jüttner, 2005; Khan and Burnes, 2007; Godfrey, Merrill and Hansen, 2009; Mandal, 2011).

Therefore, in this study, the theoretical focus is built on supply chains from the marketing perspective as being a sub-part of value networks, and the relevance of risk management from sustainability framework is further explained by the related literature.

2.1. VALUE NETWORKS IN MARKETING

Marketing activities are grouped by McCarthy (1960) under four broad categories, the 4P's; namely, product, price, place and promotion; these categories are then extended towards other additional 4P's, namely the people, processes, programs and performance by Kotler and Keller (2012) from a holistic marketing perspective. It is important for a firm to realize the importance of value creation in all categories of marketing activities, as well as in the context of networks for increasing long-run competitive potential (Lusch, Vargo and Tanniru, 2010).

Values are central to and highly important for marketing (Kotler and Keller, 2012). This is explicitly considered while defining marketing, from any perspectives. One of the best-known definition of marketing puts emphasis on the managerial role of marketing through value creation, which is defined by American Marketing Association (2008:28) as; "the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large." On the other hand, marketing also carries an important role in terms of the values created from the societal perspective. This social definition of marketing is provided by Kotler and Keller (2012:27) as "a societal process by which individuals and groups obtain what they need and want through creating, offering, and freely exchanging products and services of value with others".

A value network aims to create economic value out from the complex exchanges of goods, services, revenue, knowledge, or other intangible benefits, such as sense of community, customer loyalty, image between several parties of customers, suppliers, manufacturers, strategic partners, manufacturers and community. Thus, it is not only the revenue-generating exchanges that are considered as the value exchanges, but also the knowledge value and intangible value has equal importance in ensuring sustainable advantage. All these value exchanges are the main focus of value networks (Allee, 2000; Biem and Caswell, 2008). In this framework, value network can be defined as "any web of relationships that generates tangible and intangible value through complex dynamic exchanges between two or more individuals, groups, or organizations." (Allee, 2003:192).

Therefore, in value networks, there is a special attention to intangible assets besides tangibles. Intangible assets include relationships, trust, competency, expertise, know-how or efficiency of processes, reputation and brand, whereas tangibles are financial resources or other capital-based resources. Value networks are adapted to business practices or industry networks as the models, transforming both the intangible assets and the tangible assets into other forms of negotiable value. These networks propose a direction to convert one value into another form of value, e.g. from professional expertise to consulting services, or from purchased market intelligence reports to increased marketing competency (Allee, 2008). In value

networks, “trusting relationships” supported by a high level of integrity and transparency, is a key for success (Allee, 2003:235). It is “the system of partnerships and alliances that a firm creates to source, augment, and deliver its offerings” (Kotler and Keller, 2012:439). A value network covers a comprehensive chain of parties, including not only all tiers of suppliers and their immediate tiers of customers, but also the valued relationships with others, such as academicians or governmental bodies (Kotler and Keller, 2012).

In this perspective, supply chain is considered as a value delivery network (Kotler and Keller, 2012). It is a network of organizations that are linked through upstream and downstream relationships in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer (Christopher, 1992).

2.1.1. Supply Chain and Logistics in Value Networks

In order to understand the supply chains from a value network perspective, it is first necessary to discuss the concept of value chain and its extension towards the network of organizations. Value chain is a tool to outline directions for creating increased customer value (Porter, 1980). In the value chain model proposed by Porter (1980), a macro view of firm’s exchanges is presented through a special focus on the flow of goods, services from raw materials to consumption. The end product is at the heart of the value chain, and is surrounded by the chain performing the activities which produce it. The value is created at each process when one member passes the process onward until it reaches the end consumer. Therefore, there is a single chain of activities mostly considering one company in a specific industry. In contrast, in value networks, the organizational focus is greater than the individual company or the industry, yet it is the combination of economic actors of supply chain members in the value-creating system which come together to generate and co-produce value (Peppard and Rylander, 2006). There is interdependence between the members, and the value is created by the involvement and combination of related members. This macro view is extended towards a higher level, considering a network view of inter-organizational relationships, which reflects and addresses exchanges occurring in

today's dynamic and complex environment in a more comprehensive manner (Kothandaraman and Wilson, 2001; Biem and Caswell, 2008). This moves the focus from Porter's model, which only covers an individual firm, towards a focus which involves all related key firms in the value chain that delivers value to the end consumer (Kothandaraman and Wilson, 2001). In this sense, value networks are proposed as a model of inter-organizational exchanges which can be defined as "a complex sets of social and technical resources that work together via relationships to create economic value in the form of knowledge, intelligence, a product (business), services or social good" (Allee, 2003:192).

The key focus of value-creating networks is based on relationships between key firms in the value chain that link their core competencies to create superior value for the markets (Kothandaraman and Wilson, 2001). As inherent in the fundamental concept of marketing, "achieving organizational goals depends on determining the needs and wants of target markets and delivering the desired satisfaction more effectively and efficiently than competitors do" (Kotler and Armstrong, 1994:13), loyalty cannot be achieved through customer satisfaction alone, but also by a higher level of value created for customers by competitors (Kothandaraman and Wilson, 2001). Therefore, value-creating networks are firms that come together to create customer value (Kothandaraman and Wilson, 2001), either through the service offerings provided by the supply chains (Lusch, Vargo and Tanniru, 2010). This perspective is better reflected in the definition of value networks as "a network of facilities, possibly owned by different organizations, where time, place or shape utility is added to a good in various stages such that the value for the ultimate customer is increased." (Rudberg and Olhager, 2003:29).

Within this perspective, value-creating networks can also be labeled as supply chains, market networks or value chains (Kothandaraman and Wilson, 2001; Lusch, Vargo and Tanniru, 2010). Supply chain is also a network structure involving several direct and indirect tiers of suppliers and customers embedded by various business processes from the very initial phase until the end consumer. Thus, supply chain is a sub-part of a value network, even mostly nested with multiple value networks (Lusch, Vargo and Tanniru, 2010). Both in supply chains or value networks, customer is endogenous to the firm itself, and its related value networks and needs to be

presented with extensive service offerings to ensure satisfaction and loyalty (Lusch, Vargo and Tanniru, 2010). From a supply chain framework, markets are destination points, and the major focus of supply chains is to ensure a smooth flow of raw materials and components through the manufacturing to the ultimate sale to consumers (Kotler and Keller, 2012). The key members in the supply chain are embedded through the value propositions (Lusch, Vargo and Tanniru, 2010).

2.1.2. Supply Chain Management and its Philosophical Foundations

Supply chains' integrated nature of organizational relationships is first emphasized by Forrester (1958) as the basic argument behind the theory for distribution management. He further identified key management issues as well as related dynamics in businesses, which directly addresses the issues considered within the scope of supply chain management (Mentzer et al., 2001). Despite the discussions are older, supply chain management is an area of attention since 1980's (Oliver and Webber, 1992; Cooper, Lambert and Pagh, 1997), especially triggered by emerging issues such as, globalization, increasing demands of customers, performance-based competition or cost concerns (Mentzer et al., 2001). Supply chain management is "the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole." (Mentzer et al., 2001:18).

It is evident that the emerging competition requires an increased integration among a company and its network of business relationships (Christopher, 1992). Management of this multiple relationships and businesses is a challenging issue when considered by today's complexity and dynamism of business environments. As well as challenges, however, it also provides opportunities for improving the long run continuity and competitiveness of a business (Lambert, Cooper and Pagh, 1998; Mentzer et al., 2001). Supply chain management holds a long term orientation as "an integrative philosophy to manage the total flow of a distribution channel from the supplier to the ultimate user." (Ellram and Cooper, 1990:2). It looks to the entire

channel, not only to the individual entity or level, and helps to improve customer service while reducing the costs and provide a competitive advantage for the entire channel (Cooper and Ellram, 1993).

Supply chains, either simple or complex, are network structures in which several parties integrate their key business processes to ensure a smooth flow of products, services, information and cash, back and forth, in order to create value for the end consumers as well as for all related stakeholders (Christopher, 1992; Lambert and Cooper, 2000). Supply chains not only involve upstream and downstream firms, but also the ultimate consumers (Mentzer et al., 2001). Therefore, a supply chain can also be defined as "a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer." (Mentzer et al., 2001:4).

Supply chain management has its philosophical foundations in systems approach, which views supply chain as a single entity, rather than as individual organizations performing distinctively (Ellram and Cooper, 1990). This interrelated philosophy behind supply chain management suggests that the performance of supply chain members, either directly or indirectly affect the performance of others, or supply chain in general (Cooper, Lambert and Pagh, 1997). Besides, the philosophy behind supply chain management necessitates a customer focus or orientation (Ellram and Cooper, 1990; Mentzer et al., 2001). The Global Supply Chain Forum's definition from 1998 emphasizes this orientation provided by the concepts of supply chain management as: "the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders." (Lambert et al., 1998:1).

2.1.3. Logistics in Supply Chains

By definition, supply chain management is related to, but different from what logistics addresses. The scope of logistics as referring to the *place* dimension of 4P's (product, price, promotion, place) in marketing mix (Mentzer et al., 2001) is more comprehensive as providing a major contribution to the customer service component

of the marketing function (Murphy and Poist, 1996). It is "part of the supply chain process that plans, implements and controls the efficient and effective flow and storage of goods, services and related information from the point of consumption in order to meet customer requirements" (Lambert and Cooper, 2000:67). Thus, the definition of Council of Logistics Management in 1986, which is pointed out by Cooper, Lambert and Pagh (1997:1) explains its scope as "the process of planning, implementing, and controlling the efficient, cost-effective flow and storage of raw materials, in-process inventory, finished goods, and related information flow from point-of-origin to point-of-consumption for the purpose of conforming to customer requirements". Logistics is inherent by definition in the supply chain management concept, which provides a more generic framework, as "the integration of key business processes from the end user through original suppliers that produce products, services and information that add value for customers and other stakeholders." (Lambert and Cooper, 2000:66). Therefore, supply chain goes far beyond logistics, it brings the integration of business processes (Cooper, Lambert and Pagh, 1997), and can be defined as the management of the complete flow of goods, services, information and finance "…starting before physical distribution and meaning strategically procuring the right inputs, converting them efficiently into finished products, and dispatching them to the final destination" (Kotler and Keller, 2012:486) or as defined by the Council of Supply Chain Management Professionals (CSCMP) in 2008[1]; "encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities". Importantly, it also includes coordination and collaboration with channel partners, whether suppliers, intermediaries, third-party service providers, or customers. In essence, supply chain management integrates supply and demand management within and across companies. This integration requires close coordination and collaboration between the partners and is an important driver for value creation (Ellram and Cooper, 1990; Horvath, 2001). In contrast, logistics mostly concerns the functional silos within organizations and the understanding of supply chains is to integrate logistics; or in other words, integrate and manage key business processes in supply chains (Lambert, Cooper and Pagh, 1998).

[1] https://cscmp.org/about-us/supply-chain-management-definitions (01 February 2012)

2.2. MANAGING RISKS IN SUPPLY CHAINS

The growing complexity and competitiveness of the environments are increasing the number of risks involved. Those risks are either voluntarily or involuntarily incurred, and effect individuals, groups, communities or businesses. Although risks cannot be captured comprehensively and eliminated completely, their effect can at least be controlled. Therefore, it has becoming a necessarily important task to understand and respond to risks (Gough, 1988).

Despite having signs in mathematicians on modeling gambling (Khan and Burnes, 2007), the study on risk was first addressed by financial studies in management discipline to facilitate investment decisions (Markowitz, 1952). Risk is defined from various perspectives in the literature, such as in terms of the loss incurred (MacCrimmon and Wehrung, 1986; Chiles and Mackin, 1996; Mitchell, 1999), or as a negative outcome driven by uncertainty (Miller, 1991; Sitkin and Pablo, 1992), or as any variation in distribution of outcomes (Christopher and Peck, 2004; Manuj and Mentzer, 2008), or the degree of probability and severity (Lowrance, 1980). According to Holton (2004), exposure and uncertainty are the two essential components for an event considered as risky. One common definition is the March and Shapira (1987)'s, which is referred by Christopher and Peck (2004:2) in their studies as, "variation in the distribution of possible outcomes, their likelihoods and their subjective values".

Risks are also involved in the logistics of supply chains, which necessitates applying governance models throughout the supply chains, involving different tiers of suppliers, as well as the customers and final consumers (Cavinato, 2004). On one side, the pursuit of integration in supply chains brings many benefits, enabling improved competitiveness, including flexibility, improved quality, lower costs, and reduced lead-times; while on other side brings some problems, such as loss of control and loss of visibility (Zsidisin, Voss and Schlosser, 2007). Risk is triggered by uncertainty (Mandal, 2011). This, when combined with complexity, creates chaos (Childerhouse et al., 2003). As supply chains are going global, the risks associated with offshoring increase, such as market volatility, incomplete specifications between partners, inability or performance measurement, language barriers, cultural

aspects, lack of understanding on specific customer needs, relationship building, delivery of true value proposition to the customers (Norrman and Jansson, 2004; Ellram, Tate and Billington, 2008). In addition, core supply chain activities in common business practices can also become risk events, e.g. interruptions related to the flow of information, material, cash or demand and supply mismatch (Jüttner, Peck and Christopher, 2003). Singhal, Agarwal and Mittal (2011) specify five basic risk criteria, namely operational, market, business and strategic, product or other miscellaneous characteristics.

The risk issues associated with those definitions from different perspectives involve a wide variety of risks, such as supply disruptions, demand uncertainties, security risks, price variability, customer behavior and expectations, environmental risks, disasters, short product life cycles, network design, lack of coordination, social risks, ecological risks, and political risks. Therefore, supply chain risks address different dimensions. Manuj and Mentzer (2008:197) provide a definition for risk in global supply chain context as "the distribution of performance outcomes of interest expressed in terms of losses, probability, speed of event, speed of losses, the time for detection of events and frequency". Another definition for supply chain risk is the one stated by Jüttner, Peck and Christopher (2003:200), which better integrates the idea of risk within a supply chain context as "…any risks for the information, material and product flows from original supplier to the delivery of the final product for the end user". Tummala and Schoenherr (2011:474) conceptualize supply chain risk by addressing responsiveness and service framework specifically, as "an event that adversely affects supply chain operations and hence its desired performance measures, such as chain-wide service levels and responsiveness, as well as cost". In general, supply chain risks should be considered on the degree of their probabilities, impacts and consequences (Tang and Musa, 2011). Thus, the value of a risk can be estimated by the two major components; probability of occurrence and magnitude of loss (gain).

2.2.1. Classification of Risks in Supply Chains

The classification of supply chain risks vary further in the literature. From a broader perspective, it can be classified as macroeconomic risks, policy risks, competitive risks and resource risks (Ghoshal, 1987; Manuj and Mentzer, 2008), or it might be classified based on the sources of origin of whether it is an outcome of uncertainties or an outcome of man-made events (Tang, 2006). Chopra and Sodhi (2004) identify nine supply chain risk categories, as disruptions, delays, systems, forecast, intellectual property, procurement, receivables, inventory and capacity. Most common categorizations, however involve supply chain risk categorizations as process risks (Christopher and Peck 2004; Jüttner 2005; Lockamy III et al. 2008), business risks (Kiser and Cantrell 2006; Manuj and Mentzer 2008), control risks (Christopher and Peck 2004; Jüttner 2005; Lockamy III et al. 2008), demand risks (Christopher and Peck 2004; Jüttner 2005; Kiser and Cantrell 2006; Lockamy III et al. 2008; Manuj and Mentzer 2008), supply risks (Braithwaite 2003; Zsidisin 2003; Christopher and Peck 2004; Jüttner 2005; Hallikas et al. 2005; Ellram, Tate and Billington, 2008; Lockamy III et al. 2008; Manuj and Mentzer 2008), environment risks (Christopher and Peck 2004; Jüttner 2005; Lockamy III et al. 2008), physical plant risks (Kiser and Cantrell 2006), security risks (Christopher and Peck 2004; Manuj and Mentzer 2008; Williams, Lueg and LeMay, 2008), financial risks (Christopher and Lee 2004), chaos risks (Christopher and Lee 2004) and market risks (Christopher and Lee 2004).

Here each type of risk refers to a different variation in an outcome, such as market risk, which implies recognizing the correct signals on the market opportunities and being not responsive enough to the market changes (Christopher, Lee, 2004), security risks, which implies the adverse events threatening human resources, operations integrity and information systems leading to some outcomes as stolen data, or proprietary knowledge, vandalism, crime and sabotage (Manuj and Mentzer, 2008). Besides, as explained, although direct impact of any risk is exposed by an individual supply chain partner, it will affect the entire supply chain; e.g. the chaos in order patterns is known as bullwhip effect in supply chains (Lee, Padmanabhan and Whang, 1997), which refers to chaos risk described as the

increasing fluctuations of order patterns through up and down stream of the supply chains (Christopher and Lee, 2004).

2.2.2. Risk Management Integral to Supply Chains

Risk management is considered to be very challenging; however, globalized markets triggering growing uncertainties and products with highly shortening life cycles make risk management an inevitable, integral part of a holistic supply chain framework (Christopher and Lee, 2004; Jüttner, 2005; Khan and Burnes, 2007), not only for business continuity, but also for cost reduction purposes (Norrman and Jansson, 2004; Tang, 2006), and for business performance improvement concerns (Ritchie and Brindley, 2007). Thus, efficiency in supply chains cannot be achieved with high levels of risk (Christopher and Lee, 2004; Christopher and Peck, 2004).

The focus of studies on supply chain risk management area has evolved from a more company-specific research, mostly influenced by financial risk analysis by end of 90's, towards a high concentration of global risk issues, as well as of operational issues by the beginning of 2000's. This has recently been replaced by a point to cross-country relationship issues, information sharing, agility, resilience issues, and more critically, comprehensive supply chain coverage on risk management issues (Singhal, Agarwal and Mittal, 2011). Therefore, as complete supply chain will benefit from any risk management activity, all partners should engage in such activities, although some might only encourage, rather than directly invest, in costs of risk management activities (Ritchie and Brindley, 2007). Within this perspective, risk management can basically be defined as the process for systematically identifying, analyzing and responding to risks in an organization or throughout the supply chain (Waters, 2011), where decisions are made to reduce the effect of consequence or the probability of occurrence of a risk.

Although different definitions of supply chain risk management are available in the literature (e.g. Jüttner, Peck and Christopher, 2003; Tang, 2006; Manuj and Mentzer 2008; Sodhi, Son and Tang, 2012), fundamentally, the process of risk management focuses on reducing such negative impacts of unexpected events on businesses (Rajabinasr et al., 2013), and needs a significant focus on understanding

and reducing vulnerability in the complete supply chain, rather than in terms of any individual enterprises (Rao and Goldsby, 2009). One generic definition which better reflects the ideas behind different definitions can be given as "the identification and management of risks for the supply chain, through a co-ordinated approach amongst supply chain members, to reduce supply chain vulnerability as a whole" (Jüttner, Peck and Christopher, 2003:201). Supply chain risk management process starts with risk identification, followed by risk measurement and risk assessment, risk evaluation, risk mitigation, and finally, risk control and monitoring (Tummala and Schoenherr, 2011). Among all, it has been highlighted that the research focusing on risk identification is still in an early stage (Rao and Goldsby, 2009).

2.2.3. Supply Chain Resilience for Reducing Vulnerability

When focusing on supply chain risks in a more systematic manner, a review of the literature on supply chain resilience is inevitable, which examines reducing supply chain vulnerabilities though increased visibility, control and confidence (Christopher and Lee 2004; Christopher and Peck 2004; Manuj and Mentzer 2008; Ponomarov and Holcomb, 2009). Vulnerability is "an exposure to serious disturbance, arising from risks within the supply chain as well as risks external to the supply chain" (Christopher, Peck, 2004:3). Besides, the development of supply chain risk management strategies, such as postponement, speculation, hedging, control, share, transfer, security and avoidance, can also enable a direction for mitigating risks (Manuj and Mentzer, 2008).

In the recent years, events showing the vulnerability of supply chains and threatening the continuity of their business have increased (Jüttner, 2005). Those events have also raised the attention of practitioners, but still no managerial approach to supply chain risk management has been satisfactorily applied. Therefore, the belief that supply chain risk management should be made an integral part of an organization through e.g. enabling network transparency, joint planning for business continuity process, open share of risk-related information, acceptance and focus on joint risks, is becoming critically important for ensuring a satisfactorily increased level of vulnerability (Jüttner, 2005). Despite being given serious attention, there has

been no systematic implementation of strategies developed to mitigate supply chain risks (Christopher et al., 2011). Assessment of risk sources throughout the supply chain, defining the adverse consequences, identifying the risk drivers, and mitigating the risks in supply chains, are the four basic issues to be considered within supply chain risk management process (Jüttner, Peck and Christopher, 2003). These process stages are the managerial aspects of supply chain risk management, which is necessarily required to be handled from an integrated perspective.

There are different methodologies applied in risk management process in supply chains, such as HAZOP) analysis (Adhitya, Srinivasan and Karimi, 2009), value based process engineering (Neiger, Rotaru and Churilov, 2009), failure mode, effects and criticality (FMCEA) analysis (Tuncel and Alpan, 2010), value stream mapping (Lavastre, Gunasekaran and Spalanzani, 2012), total quality management tools (Tarí and Sabater, 2004), and simulation (Vilko and Hallikas, 2012). As supply chain risk management research is in a search for a generic definition (Sodhi, Son and Tang, 2012), there is the need for increasing the conceptual works in the field, focusing on case study methodology, and closer collaboration with industry (Sodhi, Son and Tang, 2012).

2.3. TOWARDS THE CONCEPT OF SUSTAINABILITY

Another emerging concern for businesses is related to the concept of sustainability. It is a concept of about 20 years, first proposed by United Nations' World Commission on the Environment and Development (WCED) in 1987:42 as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This framework offers for the close consideration of environmental and social decisions to better of the financials. This threefold concept of sustainability was first coined by Elkington (1997, 1998, 2004) as the TBL approach, involving the paradigm with the principle of integrating the concerns for people, planet and profits (3P). The framework of TBL argues that, to manage sustainability, the impacts of social and environmental undertakings on profitability have to be understood comprehensively (Ameer and Othman, 2012). This combined viewpoint is further given in the definition of The Center for

Sustainable Enterprise (2010)[2] as "a way of doing business that creates profit while avoiding harm to people and the planet."

However, it is not always possible to quantify the financial benefits of social and environmental performances in a short term of period. Thus, companies mostly abstain from creating on social or environmental initiatives. However, sustainability from an integrated TBL framework needs a paradigm shift from solely concern for the financial performance, to more of social and environmental concern (Azapagic, 2003). Carroll (1991) proposed the four different components for the social dimension of sustainability, with economic responsibility as again being the ground base for philanthropic, ethical and legal responsibilities. The positive effect of social and environmental performance on financial performance, and the continuity of financial development of these companies is clearly stated in many studies (Lee and Faff, 2009; Ameer and Othman, 2012).

The environmental dimension of sustainability is one of the most frequently referred dimension in the literature, and is basically concerned about the environmental responsibilities to be provided through the set of objectives, plans or other mechanisms to promote environmental friendly processes. Due to an increasing number of stakeholders, all with different goals and issues, the social dimension is an emerging dimension of sustainability which concerns both the individuals and the organizations. On the other hand, economic dimension of sustainability is the fundamental dimension of sustainability addressing the competitiveness and long term survival of a business. It not only addresses profitability, but also other financial measures, such as maintaining liquidity or ensuring a proper return to stakeholders. Although all three dimensions are conflicting in some circumstances, they coincide at some points and are complementary in nature to provide a true sustainability (Winter and Knemeyer, 2013).

2.3.1. Sustainability Research in Marketing

In early 1950's when sustainability research was at its infancy, marketing research focused mostly on ethics issues. Intellectual structure of marketing research

[2] http://www.kenan-flagler.unc.edu/cse/cse-overview.cfm (01 March 2012)

during 1990's moved towards the area of corporate social responsibility, focusing both on ethics and profitability, as well as on citizenship behavior, which points outs the importance of decisions made both implicitly and explicitly by the firms. 2000's were still more of a concern for corporate social responsibility, followed by a focus on again citizenship behavior; this time including organizational and employee citizenship aspects. This period includes issues, such as financial and social performances showing the emphasis on TBL at this period as well (Chabowski, Mena and Gonzalez-Padron, 2011).

Peter Drucker, apart from his identity of being a prominent philosopher and scholar in management discipline, is also an important contributor to the modern marketing concept, especially by being the first person to place sustainability within the domain of marketing field (Connelly, Ketchen and Hult, 2013), when he argued that business efforts should minimize social consequences, with an expectation to improve the welfare of society. Later, since WCED posited the concept of sustainability, it increasingly started to take the attention of businesses and academicians as a key factor for success and competitiveness in different areas of work (Crittenden et al., 2011). It is incorporated into a marketing perspective through developing a market orientation in sustainability issues and aligning marketing strategies into a sustainability framework (Mitchell, Wooliscroft and Higham, 2010; Chabowski, Mena and Gonzalez-Padron, 2011; Crittenden et al., 2011; Hult, 2011). This market-oriented sustainability framework necessitates a concern for environmental integrity, social equity and economic prosperity, while developing and adopting marketing strategies, and considered as a key intangible resource for business continuity and competitiveness (Elkington, 1998; Mitchell, Wooliscroft and Higham, 2010; Chabowski, Mena and Gonzalez-Padron, 2011; Crittenden et al., 2011; Hult, 2011). Business risk and business opportunity would then be supported by a better understanding of the societal as well as ecological issues and concerns provided by the orientation to a sustainable market (Mitchell, Wooliscroft and Higham, 2010; Hult, 2011). This also would allow better management of different stakeholders, as well as the relationships between them. Therefore, market-oriented sustainability can fully be achieved through an integrated formula provided by a strategic alignment of market-oriented products with its customers' needs and wants,

combined with a serious concern for the interests of various stakeholders, and adaptation of TBL understanding in business strategies (Hult, 2011). Therefore, the three dimensions of sustainability are considered as the basis for competitiveness in the marketplace (Chabowski, Mena and Gonzalez-Padron, 2011).

From a sustainability framework, the focus in value networks is to create sustainable value, through sustainable and responsible investments (Turki, 2012). Bringing different disciplines together, such as supply chain, marketing, strategic management, and finance would contribute insightful benefits to the area of sustainability (Winter and Knemeyer, 2013). Besides, sustainability studies should also be extended towards different dimensions of marketing strategies. This necessitates that the sustainability concept be extended towards supply chains from a marketing perspective (Gupta and Palsule-Desai, 2011).

2.3.2. Sustainability Research in Supply Chain Management

The interest in sustainability issues is growing due to an increase in environmental and social problems faced by global companies to other players in the international arena. Especially caused by the supply chain's attention beyond local boundaries, and their adoption of global strategies, i.e. outsourcing, bring new challenges related to different stakeholders. This necessitated supply chains to move towards a more socially responsible ground, and it has been recognized that sustainability is a paradigm which is inherently connected to supply chains (Linton, Klassen and Jayaraman, 2007; Ashby, Leat and Hudson-Smith, 2012; Ghadge, Dani and Kalawsky, 2012; Winter and Knemeyer, 2013).

The supply chain consists of organizations working together to fulfill a customer order (Chopra and Meindl, 2007). These organizations have various different and sometimes conflicting objectives or concerns. This makes it a challenge to reach to an alignment in their direction while making multi-task assessments and decisions, especially from a TBL sustainability perspective. Although economic performance is necessarily important to ensure competitiveness, environmental and social dimension is now considered to be a vital condition for building strong brand equity, as well as supporting the sales performances, and thus for ensuring economic

performance in return. Despite these realizations, it is evident that environmental and social concerns are kept in the background when compared to economic dimension of sustainability (Seuring and Müller, 2008). Particularly, environmental supply chain management has attracted increasing attention compared to social supply chain management, probably due to the fact that social aspects are less tangible and attainable, or that social goals are considered as being less critical by the businesses (Ashby, Leat and Hudson-Smith, 2012).

Strategic collaboration in supply chains is necessarily important for competitiveness, especially when sustainability is given a priority (Gold, Seuring and Beske, 2010). Firm level competition has been recently replaced by supply chain level competition, and this raises the importance of supply chains adopting an increasingly collaborative and integrated framework, considering product, service, financial and information flows. This new paradigm began to gain importance as the performance measures have been extended from financial and operational concerns towards social and environmental as well. This new shift has emerged inter-firm resources and capabilities as sources of sustained inter-firm competitive advantage (Gold, Seuring and Beske, 2010). Besides, this sustainability focus in supply chains should not only be related to the products (Seuring, 2011), but also cover the by-products manufactured (Linton, Klassen and Jayaraman, 2007). Within this framework, sustainable supply chain management can be defined as "the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements" (Seuring and Müller, 2008:1700). The main impetus towards a sustainable supply chain is the pressure on the focal companies passed towards the suppliers, which leads to close consideration of environmental and social issues associated with the wider supply chain. This calls for the development of two separate but complementary strategies; supplier management of risks and performances, and supply chain management for sustainable products (Seuring and Müller, 2008).

Therefore, sustainable supply chain management should involve a comprehensive and integrated perspective of all environmental, social and economic issues focusing on a broader part of supply chains (Seuring and Müller, 2008). Integrated communication provided in the supply chains, alignment to management standards, close monitoring and evaluation, reporting and sanctions, education or integration of goals into corporate policies, are stated as being supporting factors for sustainable supply chain management, whereas associated costs, challenges in coordination, especially in cases of high complexity, or lack of complete or correct information in supply chains are as barriers considered in the studies (Seuring and Müller, 2008). Moreover, sustainability should be inherent in different functions of supply chains, such as sourcing, transformation, delivery, value proposition, and recycling (Hassini, Surti and Searcy, 2012). At this respect, Hassini, Surti and Searcy (2012:70) provide a more comprehensive definition of sustainable supply chain management as "the management of supply chain operations, resources, information and funds in order to maximize the supply chain profitability while at the same time minimizing the environmental impacts and maximizing the social well-being". Social well-being includes not only the customers or the employees, but also the community at large. Gupta and Palsule-Desai (2011) examine sustainable supply chains from a value chain perspective, which they define as managerial activities incorporating environmental impacts, entire value chain of products and entire product life cycle in decision-making.

2.3.3. Supply Chains Moving Towards Sustainable Settings

The enabler and barriers for sustainable supply chains not only rise from internal factors to the firms, but also from the external factors in its environment (Walker and Jones, 2012). Basically, sustainability in supply chains could be achieved through three major approaches, first by integrating sustainability directly into the supply chain; second, by aligning sustainability of supply chains and adding on that; or third, by replacing supply chains and providing a completely new definition of supply chains with a sustainability framework (Halldórsson, Kotzab and Skjøtt-Larsen, 2009). Management orientation is critically important for ensuring

sustainability, especially through developing sustainability driven commitment and focus towards collaboration, innovation, performance management, employee behaviors or supplier selection and management (Pagell and Wu, 2009). Awareness is another critical and fundamental enabler of sustainability practices in supply chains, as without awareness, efforts to adopt sustainability would fail to materialize, either in enterprise-wide practices, or across other supply chain partners (Faisal, 2010a). Other than awareness, consumer concerns, regulatory efforts, top management commitment, information sharing, and collaborative relationships (Halldórsson, Kotzab and Skjøtt-Larsen, 2009; Faisal, 2010a), are also identified as being important enablers for adopting sustainability practices (Faisal, 2010a).

There are both external and internal market forces which push supply chains towards building sustainable settings in their activities. These forces would be either consumers, retailers, stakeholders, or other dynamics in the industry, such as competition provided by being socially responsible. Within this perspective, the role of consumers in sustainable supply chains is critically important, as they are the end users at the point where the products are recycled, for the purpose of renewing the consumption. Consumers' choices for buying green products needs an explicit awareness on the value proposition provided by the products; especially in cases where the price paid for greener products are relatively higher (Hassini, Surti and Searcy; 2012). Therefore, the true communication and awareness on the benefits, supported by the clear value proposition of such products, would help marketing of green consumption to consumers. At this point, the importance of training or education of, not only the supply chain partners, but also the consumers on the value provided by the greener products, becomes critical for building a complete sustainable framework. This would help consumers in the justification of, e.g., paying more for doing the right thing for the environment, and feeling justified in consuming those products.

Considering this increasing importance, it has been realized that sustainability requires significantly higher attention for various reasons. Firstly, there is a lack of appropriate and sufficient evidence showing the extent to which companies have integrated sustainability practices in their business strategies and practices, especially in terms of quantitative measures to be provided for the management of sustainability

performances (Morali and Searcy, 2013). Secondly, it has been highlighted that the theoretical background of supply chain related papers, especially in sustainability area, are often missing (Seuring and Müller, 2008). This means that the theoretical framework of sustainable supply chain studies, although considered to be necessarily important, has not been effectively employed while examining, analyzing and explaining the concepts related to sustainability (Carter and Easton, 2011). Furthermore, it is evident in Hassini, Surti and Searcy (2012)'s review paper that only a minority of studies on sustainable supply chain metrics focus on all three dimensions of sustainability, spanning across supply chain partners, or looking from an industry-specific perspective. Sustainability research still needs a detailed probing in individual industries to identify specific activities that would be applicable in their own dynamics (Carter and Easton, 2011).

Another important point is the identification of economic, social and environmental impacts and risk management across supply chains to be considered as being among the major issues by experts and researchers on the field regarding sustainable supply chain management (Seuring and Müller, 2008). By this, Carter and Rogers (2008:368) provide a definition of sustainable supply chain management as "the strategic, transparent integration and achievement of an organization's social, environmental and economic goals in the systemic coordination of key inter-organizational business processes for improving the long-term economic performance of the individual company and its supply chains". The framework presented by Carter and Rogers (2008) on sustainable supply chain management considers risk management explicitly from an integrated perspective of economic, social and environmental dimensions, and emphasizes that true sustainability, which enables higher economic performances, can only be achieved by the comprehensive incorporation of risk management, transparency, strategy and culture. Supportively, Seuring and Müller (2008) state that papers on sustainable supply chains do not carry a risk framework. They suggest further research should address the intersection between risk and sustainable supply chains. Here, the risk framework should cover all three dimensions of sustainability, including social, environmental and economic.

2.4. SUSTAINABILITY FROM A RISK MANAGEMENT FRAMEWORK

Instead of always being considered as a solution, supply chains themselves can be the fundamental cause of problems (Halldórsson, Kotzab and Skjøtt-Larsen, 2009). One example is the need to going beyond local boundaries, and globalizing the supply chains for more effective and efficient processes, while at the same time, paying for the distance processes and their social and environmental consequences.

Management of sustainability, from a corporate perspective, provides companies a better business performance with more predictable results. This necessitates investing in innovative ideas to produce products or services through the more efficient use of financial, natural and social resources; providing a responsible governance supported by organizational capability and strong corporate culture; protecting and improving shareholder competitiveness; effectively leading and directing the industry towards the standards of sustainability; and concerning for social welfare, both in local and global communities (Knoepfel, 2001). This requires a corporate level commitment and assessment by companies. This assessment would need to involve different criterion related to a dimension for evaluating opportunities, as well as for risks (Knoepfel, 2001), also in an integrated way, considering all social, environmental and economic risks triggered (Azapagic, 2003). Therefore, risk management procedures of companies should involve a sustainability orientation to ensure the continuity of businesses (Knoepfel, 2001; Azapagic, 2003; Wolf, 2011).

Accordingly, companies started to consider risk management as an integral part of sustainability, e.g. the influence of corporate social responsibility on risk management is obvious (Godfrey, Merrill and Hansen, 2009; Mandal, 2011), which provide an insurance-like protection (Godfrey, Merrill and Hansen, 2009). In particular, rather than short-term focus on financials only, it is important to consider security in supply chain, or management of risk factors causing long-term damages in supply chain to achieve sustainable development (Gladwin, Kennelly and Krause, 1995). Besides, the vulnerability of supply chains is unavoidable in this growing complexity of networks. This, coupled with increasing pressure on companies to shift their business practices from a traditional economic focused framework to a more environmentally and socially concerned structure, forced companies to adopt new

standards of sustainable business (Teuscher, Grüninger and Ferdinand, 2006). In these risk-oriented, sustainable supply chains, developing a total quality management approach, especially through building solid partnerships and adopting certificated standards by the related members, is considered to be critically important to minimize the overall supply chain risks (Teuscher, Grüninger and Ferdinand, 2006).

2.4.1. Integrating Sustainability and Risk in Supply Chain Management

Despite this emphasis on risk management from sustainability framework, risk management, transparency, strategy and culture were not explicitly defined in the definitions of sustainability (Carter and Rogers, 2008). By addressing this, Carter and Rogers (2008:366) provide a sustainability integrated definition of supply chain risk management as "the ability of a firm to understand and manage its economic, environmental and social risks in the supply chain". On the other hand, the explicit consideration of the social dimension is addressed in the definition provided by Shrivastava (2007:955) as "the potential for reducing long-term risks associated with resource depletion, fluctuations in energy costs, product liabilities, and pollution and waste management". Moreover, Teuteberg and Wittstruck (2010) explicitly showed in their model the risks associated with sustainable supply chains, and highlighted the importance of identifying and mitigating related risks for long-term profits, while covering all three dimensions of sustainability. Similarly, Wolf (2011) argued that sustainability risk management should be an integral part of supply chain management for a step towards complete integration, not only for internal processes or partners, but also for the external stakeholders.

Therefore, it has been recognized that companies can become more sustainable by adopting their risk management principles into environmental and social aspects. Regarding this concern, Anderson and Anderson (2009) explicitly announced sustainability risk in their study, and argued that sustainability, covering all three dimensions of TBL, should be approached from a risk management framework, and be an integral part of enterprise risk management.

It is now obvious that sustainability risk costs are borne by the businesses, themselves. Sustainability risk management both helps to build a better reputation, and improves financial performance, thus competitiveness. From a risk management perspective, events such as global warming, climate change, outsourcing strategies, employee discrimination, poor working conditions, hazardous waste disposal processes, ecosystem pressures, and quick access to internet all have some sustainability consequences, for at least one of three dimensions, which increase several risks related to property damages, storms, global warming liability, life and health, monetary damages, negative publicity, boycotts, reputation loss, environmental liabilities as well as social responsibility, and directors' and officials' liability (Anderson and Anderson, 2009). Within this perspective, sustainability risk management can be defined as the management of social and environmental risks (Anderson and Anderson, 2009).

2.4.2. Sustainability Issues in Relation to Supply Chain Risk

Although it is obvious that firms are suffering from serious losses due to social or environmental problems, sustainability issues are neglected in risk management studies. Therefore, the knowledge is limited on how sustainability issues materialize as risks (Krysiak, 2009; Hoffmann et al., 2013). However, the basic notion inherent in sustainability has the potential to protect against risks for future generations (Krysiak, 2009). Considering this negligence, Hoffmann et al. (2013) proposed sustainability-related supply chain risk framework in their studies. Supply chain risks are called supply chain disruptions when materialized, where supply chain risk sources are the derived categories of supply chain disruptions, and supply chain risk management aims to identify, address and manage the exposure to supply chain risk sources (Hoffmann et al., 2013). Therefore, materialization of supply chain sustainability issues as risks address to the sustainability risk sources.

Sustainability-related supply chain risks emanate from risk sources as other ordinary supply chain risks, and are all addressed by risk management. What differentiates them in context is that ordinary supply chain risks are triggered by supply chain disruptions related to product, service or financial flows, whereas

sustainability-related supply chain risks are triggered by the social or environmental reactions of the stakeholders (Hoffmann et al., 2013). Within this framework, sustainability-related risk can be defined as a condition or potentially occurring event that may provoke harmful stakeholder reactions, and thus it is a "sustainability risk within a focal firm's supply chain" (Hoffmann et al., 2013:190). Hoffmann et al. (2013) define risk as the possibility of a negative deviation from the expected major or minor performance objectives, which result in direct or indirect consequential losses in a supply chain. They propose this concept of sustainability-related supply chain risks through the involvement of stakeholders, which can act as a framework to mitigate global risks that arise from sustainability issues, and reduce the vulnerabilities of supply chains towards such risks.

2.4.3. Industrial Focus on Sustainability and Risk

When the focus is on sustainability and risk, it is important to consider a study specific to an industry, as the risks, challenges, barriers and facilitators may vary with the nature, size and type of any industry (Jüttner, 2005; Olson and Wu, 2010; Carter and Easton, 2011; Singhal, Agarwal and Mittal, 2011; Hassini, Surti and Searcy, 2012). Among several industries which put sustainability in their business focus, such as, the automotive, electronics or textile industries (Koplin, Seuring and Mesterharm, 2007; Seuring and Müller, 2008; Seuring et al., 2008), the food industry is highly concerned with sustainability, due to the sensitivity of their products and complexity of their supply chains (Cleland, D.J., 2010; Zanoni and Zavanella, 2012). Besides, risks are less acceptable in food supply chains, where risk factors could threaten product quality and safety, and thus, ultimately, public health and welfare, which ultimately emphasize the social dimension of sustainability.

Therefore, within the scope of this study, food supply chains are chosen as the focus industry when conducting the research and presenting the sustainability-oriented supply chain risk management framework.

Considering all, the theoretical focus of this study is presented next. Before going further in explaining the theoretical focus of the study, however, it is important

to clarify the terminology on risk-related issues to be used throughout the research, especially in terms of risk and hazard arguments.

2.5. CLARIFYING THE TERMINOLOGY ON RISK: RISK VERSUS HAZARD

In order to understand the comprehensive ground of this study, it is important to define basic terminology within its scope, and differentiate the meanings behind uncertainty, risk and hazard.

2.5.1. Risk and Uncertainty

Despite being used synonymously, risk and uncertainty refer to different concepts. The term risk might sometimes be confusing, as it addresses to different constructs; in some cases to a source of risk, especially when referring to uncertainty reducing outcome predictability; or to a consequence of risk (Jüttner, Peck and Christopher, 2003). In risk, there is a negative consequence of an outcome, an exposure to a loss, and a chance of realization of that loss (Gough, 1988). Here, in risk, it is obvious that there is an uncertainty in the realization of an unwanted situation, in which uncertainty represents a fully unknown outcome. Uncertainty exists in every decision to some extent, having some financial, social and environmental consequences (Gough, 1988). Different from uncertainty, risk is the probability of occurrence. In risk, the set of possible outcomes is known, and probabilities for each set of outcome can be assigned, either objectively or subjectively, whereas in uncertainty the set of outcomes are either unknown or cannot be assigned to a degree of probability (Gough, 1988). Although risk can be associated with gain, it is mostly referred as a loss or as a negative variation in an outcome (Gough, 1988).

2.5.2. Risk versus Hazard

In order to understand risks, it is also necessary to develop an understanding on the hazards; risk and hazard are not the same in meaning. The conceptual problem between risk and hazard can be clarified by distinguishing that a hazard can be considered as a risk only if it is proven as exposure, and only if it is truly effective. Basically, risk can be formulated as a function of hazard and exposure (Scheer et al., 2014). Therefore, hazard is something with a potential to cause adverse effects whereas risk is the likelihood of that hazard actually causing its adverse effect, considered in terms of its severity (magnitude) (Szajkowska, 2012). Hazards are negative outcomes, undesirable events, which are unpredictable (Lee, 1981), but have the potential to cause harm, whereas risk is the chance that the adverse effects of an identified hazard will occur (Eaton and Little, 2011). Holding the idea that hazard is anything that has the potential to harm; it is important to understand that this potential may never materialize if not exposed. However, in risk, there is a probability of exposure to a hazard or probability of occurrence of a hazard, and the extent of damage is considered in result (Scheer et al., 2014). Therefore, hazard is the source causing harm, whereas risk considers probability and severity. Despite those distinctions made between risk and hazard, a hazardous situation is sometimes referred as a risky situation, especially considering the fact that risks quantify the consequences of hazards; and thus risk identification can sometimes be identified as being identical to hazard identification (Gough, 1988).

On the other hand, Sheer et al. (2014) take a stakeholder-based perspective on identifying whether risk and hazard are perceived and understood to be the same by different stakeholders, such as public authorities, business or industries and environmental or consumer organizations. They contribute to the work of Lofstedt (2011), which highlights that risk and hazard understanding vary between European Member States, and conclude that in risk communication, risk and hazard are perceived and used in different meanings, based on the perspective or worldviews of the stakeholders. Sheer et al. (2014)'s study including interviews and focus groups by several stakeholders, confirm the previous definitions of hazard, as a potential to harm, and risk, as probability that a harm will occur.

Hazards are considered by different stakeholders as a potentially damaging event, and as an intrinsic ability or an inherent property, whereas risks are considered as the probability of exposure to adverse effects, and probability of exposure to uncertain or harmful consequences. In contrast to hazards, in risk, the probabilities, magnitudes and severities become an issue of consideration. That is, risk is the likelihood of negative consequence caused by any danger, injury, loss or damage (Harland, Brenchley and Walker, 2003). Sheer et al. (2014) also state that different industries or different disciplines also define the two terms differently, and thus while communicating among different industries or different disciplines; especially in different communication arenas, the terms and terminologies are frequently confused. They also highlight that the distinction between risk and hazard becomes more important when considered for risk management and risk assessment purposes, than for risk communication. Depending on the hazard assessment alone ignores the impact as an important driver (Lofstedt, 2011). This concludes that in risk communication, the distinction between the two terms is not critical as it is in risk assessment and in risk management (Sheer et al., 2014).

2.5.3. Other Terminologies In Risk Related Issues

There are different terminologies used to identify risk related issues. One is *risk sources*, meaning that any variables arising from environmental, organizational or supply chain related issues which cannot be fully predicted with certainty, and which effect outcome variables in supply chains (Norrman and Jansson, 2004). Another is *risk factor*, which can be defined as something which causes a risk (Freedman, 1987). *Risk assessment* involves the process of risk determination, which involves the identification and evaluation of the potential outcomes and their probabilities, and risk evaluation. While identifying risks, it is necessarily important to consider every possibility for harm, including the causes of risk, elements subjected to risk, as well as exposures to hazard (Gough, 1988).

2.5.4. Risk Terminology in the Study

Considering the above discussions, it is necessarily important to address this conceptual problem between risk and hazard terminology in this study, as this research follows an approach for building a risk management framework, not risk communication (Sheer et al., 2014).

Throughout the study, there is no attempt to quantify the probabilities of occurrences or their severities; rather the focus is more on identifying the causes of risks; that is the risk factors (Freedman, 1987). Later, these risk factors are evaluated in terms of their impacts on sustainability-related hazards, which refer to the negative outcomes or undesirable events (Lee, 1981) that potentially relate to the three dimensions of sustainability specifically.

Therefore, in this research scope, supply chain risk factors, as being the causes of risks (Freedman, 1987) that may lead to sustainability-related hazards with the potential to harm, are investigated, and discussions are labeled over the terms *risk factor* and *sustainability-related hazards* throughout the study.

2.6. THEORETICAL FOCUS OF THE STUDY

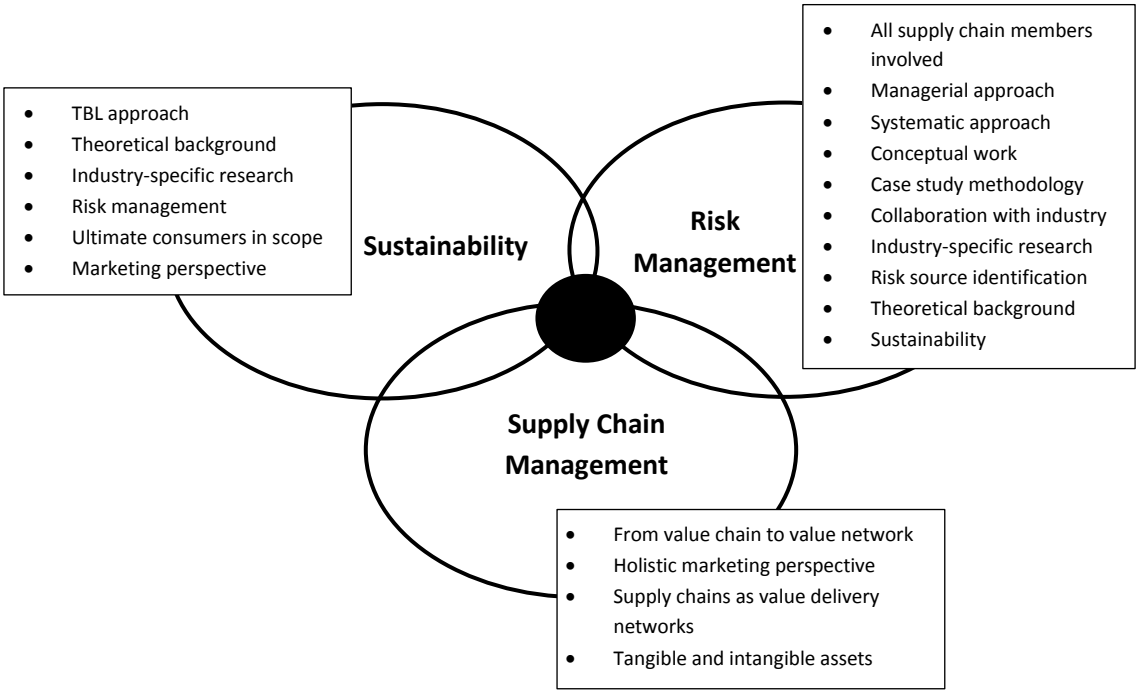
The theoretical focus of this study is based on the framework provided by the literature on supply chains, risk management and sustainability. Based on the given highlights and research gaps, the theoretical perspective and design of the study is determined.

Figure 1 shows the theoretical focus of this research, and presents the related gaps considered while designing the study.

The review of the literature outlined that, there is the need for theoretically supported studies, both for the sustainability and risk management areas. In risk management studies, the need for a holistic consideration of all supply chain members is highlighted, with a specific emphasis on consumers. This need for the involvement of consumer perspectives is mentioned in sustainability-related studies as well.

On the other hand, sustainability studies to be approached from a marketing perspective are mentioned as requiring more attention, as well as the focus of an integrated approach to sustainability with TBL perspective.

Figure 1: Theoretical Focus of the Study and Research Gaps addressed



Source: Created by the Author

Besides, the need for more attention on conceptual works, mostly approached by case study methodologies, which contributes to developing a systematic, managerial orientation to risk management literature, is further emphasized. Especially, risk identification phase is mentioned as requiring more future work. The importance of increasing the studies conducted in close collaboration with industry is highlighted as well.

Moreover, studies integrating risk and sustainability, and approaching to risk issues from a TBL sustainability framework are also highlighted as lacking.

Besides, conducting more industry-specific research is mentioned to be necessarily important for risk and sustainability fields. Considering the need for industry-specific research on risk management and sustainability studies, and that the

researches focusing on food chain are in minority, the industry focus is determined to be on food supply chains, with a specific emphasis on cold chain logistics activities.

On the other hand, approaching supply chains with value network approach taking a holistic marketing perspective, by incorporating both tangible and intangible assets, are also emphasized as necessarily required in future work.

CHAPTER III
THEORETICAL FRAMEWORK OF THE STUDY

The theoretical framework of this study is developed based on the discussions provided by the theoretical focus of the study, related to sustainability, risk management and supply chains in Figure 1, combined with the propositions and assumptions of TOC and chaos theory. Aligned with the research problem of this study, an extended framework for TOC is presented further.

However, before going further to explaining the theoretical framework, it is necessary to discuss the marketing perspective developed in this study first, by addressing the schools of thought which best reflects the view behind this thesis study, and explaining their relevance in terms of the distinct focus and different perspective provided.

3.1. THE MARKETING SCHOOLS

Marketing was first studied as *distribution*, in the earliest university course in marketing, in North America in 1902-1903. The term *marketing* was first used by economists in 1897, and was gradually replaced the term distribution. Later, marketing, as a discipline emerged in early 20th century as a branch of applied economics.

3.1.1. The Historical Debate on Marketing

The status of marketing, and whether it was an art or science, can be traced back to historical debates in the 1960's. In a search for scientific theory in marketing, the question of *Is marketing a science?* was first raised by Buzzel in 1963 (Baker and Saren, 2010). This then triggered this historical debate of science versus art, which still is being argued, and explored different views and schools of thoughts competing in marketing discipline in a search for a unified general theory.

In this debate, Alderson and Cox argue that marketing calls for a theory for being a science, while Vaile considers that marketing is and will remain an art, because of the many propositions offering opportunities for making judgment, rather than explaining (Baker and Saren, 2010). Thus, this historical debate later turned into a discussion of what form of scientific theory is appropriate for marketing discipline; realism or relativism? Following Alderson and Cox on this discussion, Hunt is regarded as being one of the most important proponents of *marketing is science* school, which later moved from the idea of logical positivism provided by the positivistic scientific methods, to a view based on scientific realism. He basically argued that objectivity is not impossible (Baker and Saren, 2010).

On the *marketing is art* side, Anderson, as an important pioneer of this view of relativistic approach, moves the focus towards critical relativism, questioning the realistic view provided by Hunt. He argues that there is no single correct method for evaluating theory, and different research disciplines should adopt different methodologies, epistemologies and ontologies. In his discussions, he referred to Kuhn (1962)'s revolutionary view of competing paradigms, which presents for the concept of incommensurability, holding the idea that there is not one single truth, as different scientists have different world views. Differently, Hunt refused all forms of relativism, and argued that, knowledge must be objective and empirically testable, and that different paradigms are not rival, despite being non-comparable; thus cannot be incommensurable. In contrast, Anderson accepted that there exists a reality in prior, but rejects the idea that this pre-existing reality can be discovered by scientific method (Baker and Saren, 2010).

3.1.2. The Schools of Thought in Marketing

The schools of thought in marketing were born from this historical debate of whether marketing is an art, or a science (Baker and Saren, 2010). A school of marketing thought, to be labeled as a different school in terms of others, must have a distinct focus, must provide a different perspective on marketing issues, and must be supported by significant number of scholars in the field.

In 1990's, the traditional schools of thought, which are commodity school, functional school, and institutional school, dominated the discipline. Later in 1960's, contemporary schools of thought, which are macro-marketing school, buyer-behavior school, managerial marketing school and systems school of marketing emerged as new approaches in the discipline. In their book, Sheth, Gardner and Garrett (1988) identified twelve different schools of marketing thought, and classified schools of marketing thought based on their degree of economic and non-economic focus, as well as based on their degree of interactive and non-interactive influences. Commodity, functional and regional schools were classified as economic-non-interactive schools of thought; institutional, functionalist and managerial schools were classified as economic-interactive schools of thought; buyer behavior, activist and macro-marketing schools were classified as non-economic-interactive schools of thought; and organizational dynamics, systems and social exchange schools were classified as non-economic-interactive schools of thought (Sheth, Gardner and Garrett, 1988). Taking a different approach, but one that overlapped the previous approach to some extent, Shaw and Jones (2005) reduced this number and identified ten schools of marketing thought, namely marketing functions, marketing commodities, marketing institutions, marketing management, marketing systems, consumer behavior, macro-marketing, exchange and marketing history schools of thought. They incorporated Sheth, Gardner and Garrett (1988)'s activist school in their new grouping with macro-marketing school of thought, and excluded functionalist school of thought, arguing that it does not fit their definition of school of marketing thought.

3.1.3. The Marketing Schools of Thought in the Study

Each providing a distinct focus and different perspective on marketing aims and objectives, the schools of thought which best reflects the view taken in this thesis study is institutional school (marketing institutions) and systems school (marketing systems). Institutional school is considered to be one of the foundations of marketing thought (Sheth, Gardner and Garrett, 1988).

Going beyond the view of commodity school, concerned with the characteristics of products, or functionalist schools, concerned with marketing activities, institutional school analyzes the organizations themselves in the marketing process. It was proposed in 1910's by Weld, who has been regarded as being its founding father. It is obvious that institutional school are concerned with the marketing institutions, including the players in channels of distribution, middlemen, wholesalers or retailers, and thus refer to the value networks or supply chains within the scope of marketing (Halldórsson et al., 2007; Ketchen and Hult, 2007; Chicksand et al., 2012; Connelly, Ketchen and Hult, 2013). However, apart from which schools of thought it basically follows, a general theory of marketing should inherently consider systems thinking (Shaw and Jones, 2005). Systems school holds a more holistic belief, arguing that total is more than sum of the parts, and views marketing as a system in which the parts are integrated and interdependent on each other. Although it is hard to identify a pioneer, Forrester (1958) and Amstutz (1967) are considered to be among the most prominent scholars in systems school of thought, as systems school of thought is recognized by the influence of operations research techniques, which then enabled marketing and marketing activities to be examined from a systems perspective. These schools also emphasize the close relation between marketing and logistics in supply chains (Svensson, 2002; Ketchen and Hult, 2007; Chicksand et al., 2012; Connelly, Ketchen and Hult, 2013).

Within this perspective, while building the theoretical foundations of this study, the main arguments and propositions are developed based on the two theories that inherently consider this framework; namely, TOC and chaos theory.

3.2. THEORETICAL BACKGROUND OF THE STUDY

The theoretical background of the study was developed after a comprehensive search in the theories, which are relevant in terms of the theoretical focus of this study. In this context, twelve theories were outlined and reviewed for their relevance on the aim and research questions of this study; namely agency theory, institutional theory, stakeholder theory, contingency theory, resource-based view, dynamic capabilities, natural resource-based view, resource dependence theory, population

ecology, transaction cost economics, TOC and chaos theory. The fundamental arguments of those theories are discussed in the following sections.

Based on the aim and theoretical focus of this study, it has been determined that the theoretical background of the study can best be grounded on TOC (TOC) and chaos theory. TOC is a philosophy of continuous improvement and primarily developed by Eli Goldratt (Goldratt and Cox, 1984). TOC is a credible theory (Naor, Bernardes and Coman, 2013) highlighting that every business has at least one constraint and constraints determine the performance of a system. Any organization's performance is limited by its weakest link or system constraint and the overall goal is to strengthen the weakest link (Blackstone, 2010). Goldratt and Cox's TOC understanding is also supported by the idea provided by the chaos theory's framework as in chaos theory reductionist view is invalidated, and it is argued that the sum of the local optimums is not equal to the global optimum (Wilding, 1998). Chaos theory is basically an evolutionary system theory. An important assumption of chaos theory is that a system is a set of parts interacting with each other while function as a unified whole; and thus small changes in initial stages of this system can amplify exponentially, and greatly impact the pattern of the system's growth and evolution. This sensitivity to initial conditions is also known as the butterfly effect (Wilding, 1998), and is reflecting the idea of potential chaos which would be created in food chains by a minor error in the very initial stages. On the other hand, in chaos theory, the importance of the involvement of all related organizational members in the strategy development process is highlighted by large group and participative approaches. This introduces and encourages the concept of self-organization, aiding to successful implementation of the strategies and unity of purpose in an organization (Bechtold, 1997).

Based on this framework, this study is structured over TOC and chaos theory to better develop and explain the idea of sustainability-oriented supply chain risk management. The main concepts and propositions of the TOC are adopted and re-defined in a risk factor and sustainability framework with a TBL approach (e.g. constraint, the goal, drum-buffer-rope, evaporating cloud, three questions of TOC and 5FS).

In this study, supply chain is taken as a unit of measure to reflect this large group and participative approaches offered by the chaos theory to address the concept of self-organization.

3.2.1. Theory of Constraints: Assumptions, Concepts and Methods

Businesses, in search for competing in today's increasingly demanding environment, developed new ways of improving quality and speed of products and services supported by better inventory management policies. This is how material requirements planning (MRPI and MRPII), just-in-time (JIT) and TOC evolved. Having some unique contributions, TOC differs from MRP or JIT systems in its underlying principles (Gupta and Synder, 2009). TOC is a philosophy of continuous improvement, developed primarily by Eli Goldratt in the early 1980s as an extension of Optimized Production Technology (OPT). In his first book *The Goal*, Goldratt conceptualized OPT for production implementation and extended his work in his second book *The Race* (Goldratt and Fox, 1986) from a focus on production alone towards a more comprehensive representation of all business processes. In this second book, the authors provided a path for managing the difficulties in implementation process and offered for different tools and methodologies for following a logical flow (Rahman, 1998). This comprehensive framework, providing a theory for the complete organization, is later referred as TOC by Goldratt in 1988.

The evolution of TOC lies in five main eras, namely, the *Optimized Production Technology Era*, in which the roots of secret algorithm are raised, the *Goal Era – 1986*, in which the foundation of TOC practice and techniques that would act as a guide to implement and follow OPT schedules is formed, the *Haystack Syndrome Era – 1990*, in which TOC measures are articulated, the *It's Not Luck Era – 1994*, in which thinking process gained areas for implementation, and the *Critical Chain Era – 1997*, in which TOC is applied to project management (Watson, Blackstone and Gardiner, 2007). *Necessary but not Sufficient – 2000* and *Isn't it Obvious – 2009* are the consequent works extending and developing the philosophy of TOC in today's businesses ((Naor, Bernardes and Coman, 2013).

A good theory should consist of four basic components; definitions of terms or variables, a domain where the theory applies, a set of relationships of variables, and specific predictions (Wacker, 1998). The quality of a theory is determined by its creativity, usefulness and scientific framework (Lewis, 1998). The theoretical strength of TOC is confirmed in Naor et al. (2013)'s study, in which they examined whether TOC adheres to the eight virtues of good theory, namely uniqueness, parsimony, conservation, generalizability, fecundity, internal consistency, empirical riskiness, and abstraction. They concluded in their arguments that TOC satisfies the overall requirements of a good theory. Besides, Gupta and Boyd (2008), in their work, evaluated and showed that TOC fulfills the basic components of a good theory and meets the criterion of a qualified theory.

The philosophy and principle of TOC lies in the logistics paradigm, which encompasses a systematic approach for solving complex problems and enables a path for continuous improvement. TOC is a systems methodology which links hard system methods (methods to outline logical structures of cause-and-effect relationships) with soft ones (behaviors, policies, perceptions, variety of views), and provides a clear path for problem-solving and continuous improvement (Mabin, 1990). 5FS, drum-buffer-rope methodology and buffer management information system are some basic methodologies offered by TOC to approach to business problems. TOC techniques are of considerable interest to Fortune 500 companies, such as M, Amazon, Boeing, Delta Airlines, Ford Motor Company, General Electric, General Motors, or by non-for-profit organizations such as Habitat for Humanity, Pretoria Academic Hospital, British National Health Service, United Nations, National Aeronautics and Space Administration (NASA), United States Department of Defense (Air Force, Marine Corps, and Navy), and the Israeli Air Force as well (Watson, Blackstone and Gardiner, 2007).

3.2.1.1. The Goal and Constraint in TOC

TOC's core idea is that every business has at least one constraint and that constraints determine the performance of a system (Goldratt, 1980). This holds the assumption that any organization's performance is limited by its system constraint,

namely its weakest link. *The goal* of an organization here is defined as to make money now and in the future (Goldratt, 1980). Therefore, the term *constraint* is a broader definition of the term *bottleneck*, and can be defined as anything that limits the performance of a system relative to its goal. Thus, from TOC framework, the main aim of an organization is to strengthen the weakest link (Blackstone, 2010) to achieve its goal.

From a TOC framework, constraints are not viewed as negative obstacles for businesses, rather viewed as opportunities addressing a positive indication for improving the performance (Rahman, 1998). Therefore, it is important for a company to find the constraint to focus on, so that those constraints can be utilized, and this process, eventually, leverages the performance of the complete system. Besides, a single focus on recent constraints might be misleading, as non-constraints are potential constraints and should never been considered as non-important.

3.2.1.2. Five Focusing Steps of TOC

Five focusing steps (5FS) of TOC propose a path towards identifying and breaking the constraining factors and managing that change. The steps are basically;

1. Identify the system constraints (to define the drum/constraint);
2. Decide how to exploit the system constraints (to develop buffer);
3. Subordinate everything else to the above decision (to tie with a rope);
4. Elevate the system constraints;
5. If, in the previous steps, the constraints have been broken, go back to Step 1, but never allow to inertia to become the system constraint (Goldratt and Cox, 1984).

3.2.1.3. Drum-Buffer-Rope Application

On the other hand, drum-buffer-rope is an application of TOC which is explored primarily from OPT. TOC utilizes this different methodology for implementing its logistical system in order to manage production environments to maximize throughput.

Drum refers to the constraint that beats out for the system to follow, *buffer* refers to safety, or a set of material to allow the resource for catch up, and *rope* refers to the signaling mechanism used to link and synchronize the system (Cox and Schleier, 2010).

3.2.1.4. Thinking Process and Three Questions

A more generic approach to TOC is offered by the *Thinking Process*, which is the major component underpinning all other parts of the methodology (Mabin, 1990). TP is utilized for management of enterprises for developing strategies, or in functions of human resources management, sales, marketing, and finance. It addresses policy constraints to enable investigation, analysis, and solutions for complex problems.

By TP, Goldratt (1990) conceptualizes TOC as fostering and systemizing the management of change and continuous improvement over three basic questions: *What to change?*, to identify the right changes to follow and the wrong to avoid, *What to change to?*, to identify potential solutions and, finally, *How to cause the change?*, to identify the path for a shift towards change.

3.2.1.5. Logic Diagrams to Address The Three Questions

There are different tools or logic diagrams offered by TOC to answer to the three basic questions of TOC; namely the current reality tree, evaporating cloud, negative branch analysis, future reality tree, prerequisite tree and transition tree (Scoggin, Segelhorst and Reid, 2003).

Current reality tree and evaporating cloud is mostly used to outline and understand the current situation and identify basic conflicts to answer the question of *What to change?*.

Negative branch analysis, future reality tree and evaporating cloud mostly answer the question of *What to change to?*, and are used to work on and outline the proposed changes and ensure on their effectiveness.

Prerequisite tree and transition tree are mostly used to answer to question *How to cause the change?*, by providing an action plan for implementation (Rahman, 1998; Scoggin, Segelhorst and Reid, 2003).

TP process is pointed to by experts as one of the most effective approach as offered by TOC for running the businesses (Rahman, 1998). TP and related methodologies are also valued by several researchers for different purposes (Boyd, Gupta and Sussman, 2001; Rahman, 2002; Kim, Mabin and Davies, 2008), e.g. strategy formulation and applied on strategic planning process (Boyd, Gupta and Sussman, 2001).

3.2.1.6. Throughput, Inventory and Operating Expenses

TOC proposes three basic measurements as *throughput*, *inventory* and *operating expenses*, to measure the goal of an organization, and to be the central to all other logical assumptions (Goldratt, 1990; Gupta and Snyder, 2009). *Throughput* refers to the rate of money generated by the system through the sales realized. *Inventory* refers to all money bounded by the system. *Operating expenses* refers to the money spent by the system, while inventory is transformed into throughput (Goldratt and Cox, 1984).

The throughput-focused thinking offers an understanding where the main aim of a business is to make money, not to save money or reduce costs. Goldratt (1990) argues that there is a strong relationship between the three TOC measurements and net profit generated by the system.

3.2.2. Theory of Constraints in Value Networks

TOC was first applied to production only ten years ago; but today, TOC framework is applied to different functions of organizations, such as operations, finance, project management, supply chains, marketing, sales, employee management and strategy development in order to present the generic conflicts inherent and propose for alternatives for breaking this dilemma (Blackstone, 2010).

Besides, it is not limited to for-profit companies; also applicable to not-for-profit organizations and government agencies (Blackstone, 2010).

Therefore, a constraint could be an operation, a resource, a machine or even marketing, sales, managerial policies or lack of a market (Rahman, 1998; Blackstone, 2010). Gupta and Boyd (2008) review TOC and extend TOC as a unified theory for operations management by its new paradigm, and advise to implement TOC on different functional areas such as accounting or marketing.

3.2.2.1. TOC as a Systems Methodology

Although TOC was initially raised as a production scheduling methodology and as an approach of managing a factory, it later turned out to be a systems methodology, and was applied to conceptualize, understand and explain the dynamics and interrelationships in marketing as well as in supply chain management issues (Mabin, 1990; Pérez, 1997; Cooper and Loe, 2000; Rahman, 2002; Simatupang, Wright and Sridharan, 2004; Cyplik, Hadaś and Domański, 2009; Gupta, Sahi and Chahal, 2013; Oglethorpe and Heron, 2013).

In marketing, TOC framework is utilized especially when working on product-mix decisions (Linhares, 2009; Cannon, Cannon and Low, 2013). In this respect, the primary concern of a business is to find the optimum product mix with a constraint in production, leading to problem of capacity. Here, rather than ignoring the time spent on bottlenecks and selecting the products with higher margin coupled with priority only, TOC proposes to select products with higher throughput per time spent on the system constraints (Linhares, 2009).

Another argument is presented by Gupta, Sahi and Chahal (2013) that TOC and market-orientation complement each other. They argued that a market demand or a market policy can also be constraint to a business and TOC framework would help examining and implementing market orientation concepts systematically, while improving business performances.

Differently, TOC contributes to the marketing education systems as well. Cooper and Loe (2000) present a classroom application in using TOC for improving problem-solving skills in marketing.

3.2.2.2. Supply Chains from the Framework of TOC

Supply chains, as considered to be value delivery networks, relates to the framework provided by TOC. This is mainly because, managing a complete supply chain can be considered as extending the same logic towards managing a factory (Pérez, 1997).

TOC approach holds system thinking in its fundamental assumptions, and thus views every process as part of a matrix of chains. In TOC, it is aimed to outline the weakest link in the chain through examining the basic relationships of the complete chain and its parts, which might be either a constraint, or non-constraint (Pérez, 1997).

TOC also shed lights on different supply chain problems, and provides a theoretical framework on various studies, such as measuring and enhancing supply chain performances (Ainapur, Singh and Vittal, 2011), supply chain coordination (Leng and Chen, 2012); outlining bottlenecks in freight transportation (Bernardi de Souza and Pires, 2010; Almeida, Penaforte and Yamashita, 2013), stock management (Cyplik, Hadaś and Domański, 2009; Dos Santos et al., 2010; Wu et al., 2013); agile manufacturing (Ifandoudas and Chapman, 2009); operations at small business enterprises (Kohli and Gupta, 2010).

3.2.3. Chaos Theory: An Evolutionary System Theory

Chaos theory has its roots in physical sciences, natural sciences as well as mathematics (Doherty and Delener, 2001). It is considered as an evolutionary system theory holding the idea that set of parts interact together as a unified whole and form up a system (Bechtold, 1997).

In order to understand chaos theory, it is first important to explain its difference from the complexity theory. Complexity theory differs from systems theory as it holds the assumption of nonlinearity and non-equilibrium, whereas systems theory assumes systems with linear relationships exist in equilibrium. Complexity theory has three major areas of research; algorithmic complexity, concerning the complexity in describing system characteristics, aggregate complexity,

concerning the individual elements forming complex behaviors, and deterministic complexity, concerning the interactions of two or more variables forming major changes in stable systems.

Chaos theory is the part of complexity theory which deals with deterministic complexity. Deterministic complexity can either be explained from the view of chaos theory, or from the view of catastrophe theory. Chaos theory assumes a chaos resulting from the randomness of an underlying order. Catastrophe theory assumes abrupt variations resulting from a minor change (Manson, 2001). Chaos theory and thus complexity theory are considered to be the evolutionary systems theories (Wilding, 1998). Different from the systems theory, they view systems as being nonlinear, complex and dynamic (Warren, Franklin and Streeter, 1998).

3.2.3.1. Central Assumptions of Chaos Theory

Chaos theory views systems as complex interconnected parts having nonlinear relationships, producing unpredicted outcomes, and considers that deterministic conditions might produce unpredictable outcomes (Hibbert and Wilkinson, 1994; Levy, 1994; Tetenbaum, 1998). This opposes with the Newtonian science, which assumes a ruled, predictable universe with linear relationships (Tetenbaum, 1998). Central assumptions of chaos theory are nonlinearity, negative-positive feedbacks, bifurcations and phase changes, strange attractors, scale, fractals and correspondences, self-organization and self-renewal (Murphy, 1996). System in chaos theory is defined as a complex system with a large number of interacting parts, which are highly inter-linked with positive and negative feedback loops operating under both deterministic and random phenomena, and continuously, being transformed into a different state which is co-evolved with its running environment (Cambel, 1993; Bhattacharyya, Rangarajan and Vyas, 2012). *Positive feedback* pushes the system out of the equilibrium; whereas *negative feedback* draws it back (Stacey, 1995).

Stacey (1995) defines the parts of a complex system as *agents*. Agents are the main drivers of an evolution of a system, which are functioning units self-organizing themselves, having limited resources, intelligence and energy. In chaos theory, the

system is operating under disequilibrium in which there is no structure with random phenomena and high uncertainty. The state of change is embodied in the structure of the environment. The state of change is triggered as a result of a chain-reaction, which means the repeated iterations of interactions of the agents (Bhattacharyya, Rangarajan and Vyas, 2012).

Chaos theory seeks to understand the dynamic systems with unpredictable and non-linear behaviors, continuously transforming into higher levels of complexity. Due to the non-linearity of the systems, small changes in the initial stages grow exponentially, causing a major impact and a permanent change on the evolution of the system (Forrester, 1958; Bechtold, 1997). In chaos theory, *disturbance* is defined as this small change or variation in a regular state of equilibrium, which is a precursor for the emergence and triggering of change as well as evolution (Bhattacharyya, Rangarajan and Vyas, 2012). Chaos theory offers strong connections both with the internal and the external environment in order to enhance and ensure co-evolution. *Bifurcation points* are the nodes of progress that trigger the transformation of a system. In order to manage the uncertainty in and turbulence of its environment, all organizational members need to make continuous evolution a part of their strategy development process (Bechtold, 1997). The disorder, instability, irregularity, and thus, chaos are the elements which drive a system far from equilibrium, and force a system to innovate, create and change (Stacey, 1995).

Despite the dynamic nature of such systems, there is an internal mechanism, namely the *strange attractor*, which stabilizes and guides this evolutionary progress and avoids the system being propelled into chaos. Besides, there is a *feedback mechanism* which triggers the system to modulate, either to keep status quo or to change into new forms.

Thus, with its stabilizing mechanism, systems in chaos theory are considered to be self-organizing, and co-evolving with its dynamic environment, holding the assumptions of *emergent order* and *self-generation* (Bechtold, 1997).

3.2.3.2. Chaos Theory from Different Perspectives

Chaos theory has been studied by many researchers in different areas, and from different perspectives. Stacey (1995) discusses the propositions of complexity theory as an alternative framework providing different insights on the strategic change process. Besides, complexity theory is also offered as an alternative approach for examining supply chain risk (Colicchia and Strozzi, 2012). Cartwright (1991) explains the relevance of chaos theory to planning and presents the implications for planners. Cartwright (1991) defines chaos as an invisible, unpredictable order which implies uncertainty by emphasizing that it is not possible to predict chaotic behavior, but it may be possible to understand the underlying order, and that a highly chaotic behavior might be ruled by a simple order. Holbrook (2003), in his book-review essay, provides a good summary of chaos and complexity theories, its key concepts, themes, and important issues, and refers mainly to dynamic open complex adaptive systems (DOCAS). Eidelson (1997) present the implications of complex adaptive systems on social and behavioral sciences. He defines complex adaptive system as the unavoidable evolution of interconnected diverse parts in the nonlinear nature of the environment. Chaos, here, holds the paradoxical phenomenon of deterministic rules, leading to unpredictable outcomes. Bechtold (1997) introduces chaos theory as an appropriate model to boost strategy development in today's turbulent environment. Tetenbaum (1998) argues the paradigm shift from an orderly world towards the world of orderly chaos. They explain this shift around six primary precursors; advanced technology, increasing globalization, harsh competition, continuous change, increase in speed and increased complexity.

3.2.3.3. Chaos Theory in Marketing Systems

Marketing is system of nonlinearities, namely, the disequilibrium mechanisms, which are planned to reduce the effects of complex dynamics (Forrester, 1958; Forrester, 1961; Hibbert and Wilkinson, 1994). Thus, it has been accepted that complex dynamics do exist in today's evolving and co-evolving turbulent marketing systems with complex random patterns of behavior, and these nonlinear marketing

systems can strongly be explained by the laws of chaos theory (Forrester, 1958; Forrester 1961; Hibbert and Wilkinson, 1994; Doherty and Delener, 2001). Holding this statement, the presence and relevance of chaos in marketing systems are addressed in the literature, and implications of chaos theory for marketing theory and practice are provided. This is done by describing the concepts and issues of marketing and management from the principles of chaos theory as well as from discussing marketing and management issues over basic assumptions of chaos theory (Hibbert and Wilkinson, 1994; Doherty and Delener, 2001).

One assumption to be considered is the nonlinearity in markets, which highlights the small changes at any level of a system having dramatically big impacts on other levels. This was first cited by the concept of butterfly effect by Lorenz (1963), which is explained as being the concept of disproportionality between cause and effect. The other is the system state of the markets, which highlights the sensitivity to initial conditions leading to instability. In chaos, the presence of unstable but bounded behavior is discussed. There is an extreme sensitivity to initial conditions, also in marketing systems, creating exponentially growing impacts on further steps. The dynamics of the industrial systems are revealed by the sensitivity of different levels of the system to even small changes in other levels, which in the end hinders long-term prediction (Forrester, 1958). Thus, systems having similar starting conditions might behave completely differently during progress, and end up in a complete different situation. This situation points out that small changes in initial conditions can produce great impacts on the behavior and evolution on the system. Thus, even when the rules governing a behavior are known, it may not be possible to predict that system behavior.

Last one is the emergent order assumption, which highlights the intrinsic effort towards stability as a precursor to evolution in response to the chaotic situation. This is explained by the concept of self-organization (Doherty and Delener, 2001). Therefore, a global marketplace can be viewed as a self-organizing system (Tetenbaum, 1998). This coevolution is triggered by the actions of various market actors, such as competitors, customers, governments and the deployment of multiple marketing strategies, and therefore continuous alignment of those strategies in line

with changing customer expectations is necessary to survive in today's turbulent markets (Doherty and Delener, 2001).

Chaos theory offers alternative ways to explain and predict evolution in marketing systems. It indicates that chaotic behaviors are managed through modifying the rules and interactions among the marketing system participants (Hibbert and Wilkinson, 1994), including the consumers. Winsor (1995) introduces a new phenomenon, namely percolation, to explain marketing dynamics, and utilizes this concept to provide an insight to the adoption process of consumers. He considers marketing environments as being chaotic, and proposes the concept of percolation to explain the deterministic actions of marketing systems in stochastic mediums, and contrasts it with the popular metaphor of marketing, diffusion, as actions being governed by deterministic mediums.

3.2.3.4. Supply Networks as Complex Adaptive Systems

Chaos theory explains the dynamics in the value networks as well. There is an increasing understanding on a shift from linear supply chains towards international supply networks as being complex adaptive logistics systems, which self-organize themselves, and co-evolve through the interactions with the complex and dynamic environment, while performing nonlinear behavior due to increased complexity, diversity, and thus sensitivity to changing environments triggered by the uncertainty surrounding them.

Besides, butterfly effect, suggested within the framework of chaos theory, is also observed in logistics systems; re-named as the bullwhip effect (Forrester, 1961; Lee, Padmanabhan and Whang, 1997) to highlight the sensitivity to a shift in initial conditions leading to chaotic and extreme outcomes through non-linear dynamic processes. Therefore, considering the ways of building robustness to keep stability through self-creating and self-reference in cases of external triggers to change, allows researchers to define supply network structures as complex adaptive logistics systems, rather than just a system (Levy, 1994; Wilding, 1998; Choi, Dooley and Rungtusanatham, 2001; Surana et al., 2005; Stapleton, Hanna and Ross, 2006; Pathak et al., 2007; Hwarng and Xie, 2008; Hülsmann et al. 2010).

There are independent effects which interact and cause dynamic behavior in supply chains, as the concept of supply chain complexity triangle, and the understanding of the success of a supply chain is dependent on stability and consensus, as well as innovation and competitive advantage generated by the complexity forcing supply chains to develop, change and evolve (Wilding, 1998). The increase in the numbers of echelons, channels, partners or interactions in as supply chain increases the level of complexity which cause external risks, and the importance of the ability of this system to deal with those external risks to support the adaptation and evolution (Hülsmann et al., 2007). This accident-sensitive nature of international supply networks also arouses external risks caused by the high complexity of hyperlinks, interactions, relationships, and other dynamics of the environment of increased number of partners (Hülsmann et al., 2007). Chaos theory also allows for the possibility of the predictability of a random behavior (Wilding, 1998).

Wilding (1998), in his work, proves that deterministic chaos does exist in supply chains, and the main assumptions of chaos theory are congruent for supply chain systems as well. Chaos theory emphasizes the importance of the complete consideration of all supply chain members in the strategy development process through large-group and participative approaches. (Bechtold, 1997). Especially, this idea of reinforcing unity of purpose through the involvement of all related organizational members, introduced supply chains as a self-organizing system (Goldratt and Cox, 1984; Bechtold, 1997; Wilding, 1998).

Following this assumption of chaos theory, and considering the academic need for supply chain-wide studies (Carter and Easton, 2011; Hassini, Surti and Searcy, 2012), the unit of analysis in this thesis is identified as supply chains.

3.2.4. Extending Theory of Constraints to Sustainability-Oriented Risk Management Framework from the Perspective of Chaos Theory

TOC provides a theoretical framework with its techniques for studies to identify a path for and adapt to new business models supporting sustainable development. In theory extensions, the map provided by the theory itself needs to be

expanded through the findings of the research, and new application areas of existing theories should be offered for a better structuring of theory (Handfield and Melnyk, 1998).

Based on those, this study can be considered as an attempt to extend TOC to a new application area related to sustainability-oriented risk management framework provided by the theoretical focus of this thesis. The argument behind this is explained and combined with the propositions offered by chaos theory.

3.2.4.1. Re-defining Fundamental Concepts of TOC

Within this scope, the two fundamental concepts of TOC are re-defined, drum-buffer-rope application in TOC is adopted, and the three questions of TOC are re-expressed by integrating sustainability concerns in a risk management framework. Then, the sustainability conflict behind this research problem is presented in a risk management framework by utilizing the structure of evaporating cloud. This is followed by the thinking process, which is reconstituted by revising the five-focusing steps accordingly.

3.2.4.1.1. Re-defining The Goal and Constraint

First and foremost, *the goal* and *constraint* as being the two fundamental concepts in TOC are re-defined from the framework of a sustainability-oriented risk management.

In TOC, the goal of a business is defined as to make money in the present, as well as in the future (Goldratt and Fox, 1986). This explicitly addresses the economic dimension of sustainability, which indicates the need for improving and sustaining financial performance of a company. However, considering that the economic dimension should also incorporate social and environmental consequences for a true sustainability (Carter and Rogers, 2008; Seuring and Müller, 2008), *the goal* of a business is re-defined as a *TBL-oriented goal* as;

- *to make money in the present as well as in the future with increased concerns for social and environmental impacts*.

Constraint in TOC is defined as anything that limits the performance of a system relative to its goal. In this study, this limitation is considered to arise from the risk factors that have negative impacts on all three dimensions of sustainability, which ultimately limit the performance of the system from achieving its *TBL-oriented goal*. Thus, when considered in the context of this study, a *constraint* is re-defined as;

- *any risk factors in supply chain logistics operations that cause sustainability-related hazards*.

3.2.4.1.2. Re-defining Drum-Buffer-Rope Application

To extend this framework, drum-buffer-rope application in TOC is adopted in an integrated view provided by sustainability and risk management.

In TOC, the constraint is considered to act as a drum that beats out a pace for the system to follow and is identified to be the core conflict.

Within the context of this study, the drum, thus the core conflict in TOC, addresses to the risk factors in supply chain logistics operations that not only cause economic sustainability-related hazards, but also social and environmental sustainability-related hazards. Thus, *drum*, in this study, refers to;

- *the risk factors in supply chain logistics operations that are the common causes of sustainability-related hazards for all three dimensions (economic, environmental, social).*

The buffer in TOC is defined as a set of material that insulates the constraint from the rest of the system. This is also referred as the safety for the protection of the core conflict. In the proposed context, any mitigation strategies that reduce the

negative impact of risk factors on sustainability-related hazards are considered to be the buffers which safeguard the entire system. Thus, *buffer* in this study is referred as;

- *sustainability-oriented risk mitigation strategies in supply chain logistics operations*.

The rope is defined in TOC as a signaling mechanism that runs from the constraint to material release. Therefore, it synchronizes the entire system. Some mitigation strategies directly serve to improve the integration across several business processes. Accordingly, *rope* in this study is referred as;

- *sustainability-oriented risk mitigation strategies that help to synchronize supply chain logistics operations*.

3.2.4.1.3. Three Questions of TOC Re-visited

Furthermore, TOC utilizes the three questions approach, and constantly cycles through them in order to maintain and ensure continuous improvement.

The first question, *What to Change?*, simply explains doing what should be done, and not doing what should not be done. In this study, it has been suggested to manage all risks, not only those with economic consequences. This explains the approach to be changed in risk management framework as;

- *managing the risk factors in supply chain logistics operations that causes economic hazards.*

The second question is, *To What to Change?*, which requires a generic analysis through thinking process in TOC, and explains the directions and roadmap of change required. In this study, it is proposed to change the approach from considering only the risk factors causing economic-hazards, to considering all risk factors causing sustainability-related hazards of all three dimensions. Thus, in this study, there is a shift towards the proposed direction of;

- *managing all risk factors in supply chain logistics operations that cause sustainability-related hazards*.

Third question *How to Change?*, requires a paradigm shift. This is the part in which an explanation is given for how the real shift towards the change will happen. For this, the pathway is proposed in this study through

- *developing a sustainability orientation on supply chain risk management programs, which needs to be assessed continuously to prevent inertia.*

3.2.4.1.4. Evaporating Cloud of Sustainability-Oriented Supply Chain Risk Management

TOC framework with the use of evaporating cloud methodology is adopted to operations, supply chains, marketing, employee management and strategy development in Blackstone (2010)'s work in order to provide a visual presentation of the trade-off dilemma and different paths to be followed for resolving the conflicts. Therefore, the fundamental research problem of this study is presented by utilizing the evaporating cloud methodology of TOC.

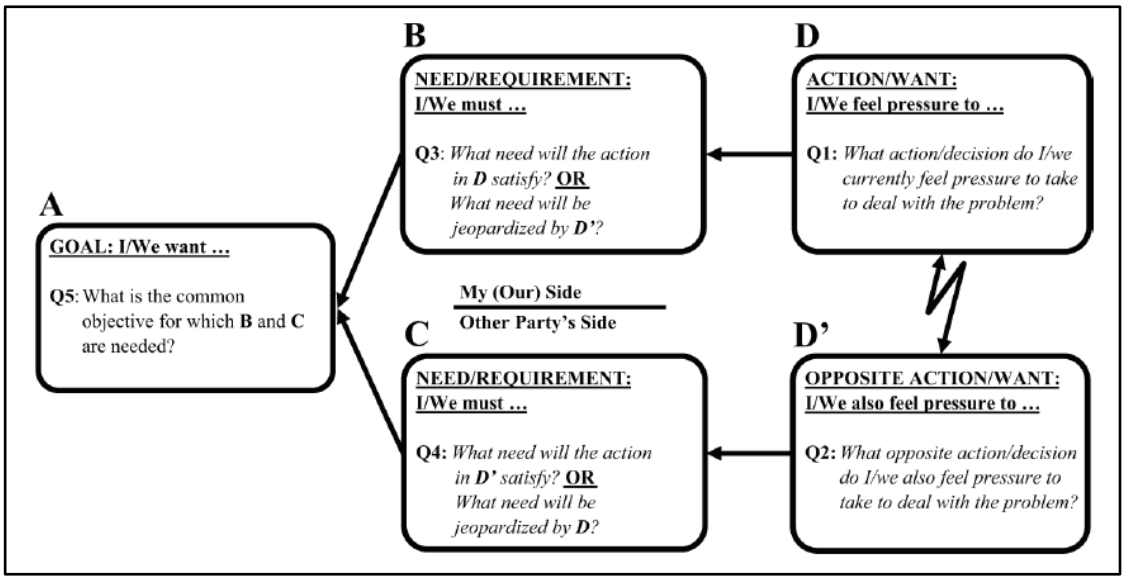
Evaporating cloud methodology, which was first introduced by Goldratt in 1990s, helps to search for a solution to core problems identified in *What to change?* question. It addresses the conflict in trade-off situations and visualizes the dilemma as well as the alternative path that should be followed for resolving the conflict (Kim, Mabin and Davies, 2008).

Evaporating cloud utilizes five boxes to identify two opposing ideas, as presented in Figure 2. First, the related conflict, then the basic need to be satisfied with that idea and the common objective that both ideas are eventually aiming to fulfill (Mabin, 1990), are shown in the evaporating cloud. This provides a clear representation of the basic conflict and the trade-off idea in opposition, and also visualizes the common objective to be achieved.

Although, this helps to draw a roadmap which brings both opposing ideas into a same ground of solution, the use of evaporating clouds in researches while

defining core business conflicts and dilemmas are not particularly common (Kim, Mabin and Davies, 2008).

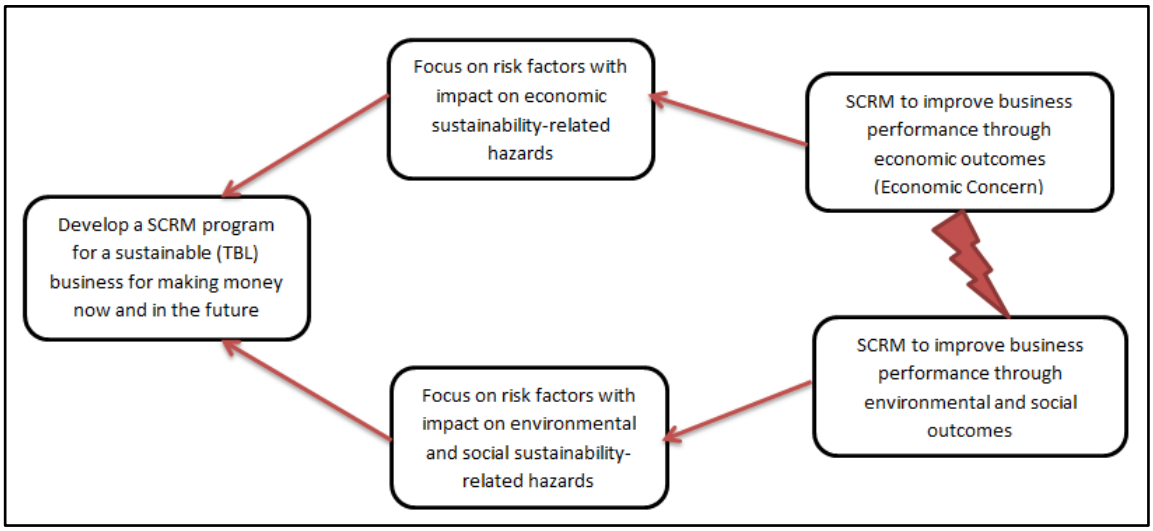
Figure 2: Structure of the Evaporating Cloud



Source: Gupta et al., 2011

Considering this opportunity and TOC framework, the sustainability conflict behind this research problem in a risk management framework is presented by utilizing the structure of *evaporating cloud* as presented in Figure 3.

Figure 3: Evaporating Cloud of Sustainability-Oriented Supply Chain Risk Management



Source: Created by the Author (adopted from Gupta et al., 2011)

3.2.4.1.5. Enhancing Theoretical Foundations of TP Methodology

Besides, the need to combine TP methodology with other methods or methodologies, and enhancing its theoretical foundations is also emphasized by Kim, Mabin and Davies (2008) as being an important area of research. Although, they mostly highlighted the techniques covered by production, management science or operations research, and did not consider that social science methodologies should be combined with the theoretical lens of TP, in this study, TP framework and techniques are combined and extended towards social science methods. Moreover, the gap in the literature in terms of utilizing TP methodology in supply chain management fields in order to explain and understand inter-organizational issues, rather than exploring the issues related to a single company (Kim, Mabin and Davies, 2008) is also covered in the scope of this thesis.

In TP methodology, 5FS are presented to address the second question of TOC *To What to Change?*;

TOC's 5FS are as follows:

Step 1: Identify the system constraint.

Step 2: Decide how to exploit (not waste the potential of) the system constraint.

Step 3: Subordinate everything else to the above decision.

Step 4: Elevate the constraint.

Step 5: If, in the previous steps, a constraint has been broken, go back to Step 1.

- TOC's 5FS are regenerated towards a *Sustainability-Oriented Supply Chain Risk Management* as follows:

Step 1: Identify supply chain risk factors

Step 2: Incorporate sustainability orientation in supply chain risk factor assessment

Step 3: Implement sustainability-oriented supply chain risk mitigation strategies

Step 4: Maintain sustainability-orientation in supply chain risk management strategies (for making money now and in the future with increased concerns for social and environmental impacts).

Step 5: Supply chain-wide continuous assessment – Do Not allow INERTIA

3.2.4.2. Re-conceptualizing Chaos Theory from Sustainability-Oriented Risk Management Framework in Supply Chains

The framework provided by chaos theory provides useful insights on conceptualizing and explaining risk factors that supply chains might come across (Knemeyer, Zinn and Eroglu, 2009). Besides, the relevance of chaos theory in sustainability issues is addressed in many studies (Levy, 1994; Mannermaa, 1995; Murphy, 1996; Surana et al., 2005; Cruz, Pedrozo and Estivalete, 2006; Rassafi, Poorzahedy and Vaziri, 2006; Nooteboom, 2007; Bhattacharyya, Rangarajan and Vyas, 2012; Porter and Derry, 2012).

Chaos is common in socio-economic systems as they show nonlinear behaviors (Rassafi, Poorzahedy and Vaziri, 2006). Bhattacharyya, Rangarajan and Vyas (2012) presents a set of procedures to structure chaos based on its degree of sensitivity, complexity, uncertainty and potential or incurred loss, by giving examples from India, and by considering social, economic and environmental

disturbances while rating chaos with respect to the sensitivity to initial conditions. Murphy (1996) highlights the need for organizations to be highly concerned about social issues while evolving in order to succeed for the long term. Murphy (1996) discusses the assumptions of chaos theory to explain public relations issues, and recommend organizations to utilize chaos theory to identify and control public perceptions. This point of view supports the idea of social sustainability. Levy (1994) in his conceptualization of supply chains as complex, non-linear dynamic systems, suggests that the supply chains do not follow a stable pattern, as they are exposed to several disruptions at any point in time. Those disruptions are chaotic events which create negative economic, social and environmental disturbances (Bhattacharyya, Rangarajan and Vyas, 2012). Nooteboom (2007) conceptualizes social systems as complex adaptive systems, highly dependent to earth system, requiring sustainable development for long term survival. A system, whether an ecosystem, market system or a social system, competes for survival, and is embedded in its resources and changing larger environment.

There is a full dependence on eco-systems, thus on sustainable earth system. Survival in this dynamic nonlinear complex environment necessitates adaptation, and is only possible through sustainable development for such systems. Nooteboom (2007:646) define sustainable development from a complexity perspective as "a system has a sustainable development if that development enables it to maintain its wholeness as an integral system, whilst also maintaining its role as part of a larger system on which it depends". Moreover, hyper competitive environments involve complex dynamic systems of nonlinear behaviors. This growing competitiveness in the marketplace is now concerned with social and environmental pressures for sustainable development, which brings more complexity and greater pressure for change to businesses, requiring the satisfaction of all stakeholders, not only of shareholders (Cruz, Pedrozo and Estivalete, 2006). Porter and Derry (2012) develop a complexity approach towards sustainability issues in complex adaptive systems and conceptualize the basic dimensions of sustainability by complexity paradigm.

The interdependence of species and ecosystems, concerning all of the stakeholders surrounded by different external organizations, is explained by the butterfly effect metaphor, raising the idea of small changes in one part of a complex

system leading to a major effect in another part. Besides, the concern for long-term impacts and performance systems going beyond economic concerns are also conceptualized with the complexity paradigm. Porter and Derry (2012) view sustainable systems as complex, nonlinear systems of holistic perspective, with an unpredictable dynamic environment. Mannermaa (1995) also conceptualize societal systems as chaotic systems. Mannermaa (1995) present the chaotic nature of societal systems as the systems holding the principles of non-linearity, self-organization and emergent and dynamic properties. Major changes leading to chaos also bring evolution, and thus sustainability. Societies with sustainable relations to nature can survive in the long term. The evolution in societal systems is caused by increasing environmental concerns, rising knowledge, more intensively ethical and environmental conscious societies, and globalization triggering the change and adaption. Mannermaa (1995) conceptualize societal systems by chaos as dynamic non-linear systems, recalling the progress towards a new form.

By considering the above discussions, a *chaotic event* is defined from the focus of this study.

- *A chaotic event within a sustainability framework is any situation, in which disturbances having negative economic, social and environmental outcomes, occur.*

3.2.4.3. Supportive Assumptions of TOC and Chaos Theory

This TOC framework described to present the theoretical argument behind sustainability-oriented supply chain risk management also relates to chaos theory. In some circumstances, the assumptions of TOC collide with chaos theory. Within this perspective, major links between the two theories from this study's perspective, are outlined.

3.2.4.3.1. The Holistic Perspective

Chaos theory does not hold the reductionist view (Widing, 1998). This is also mentioned in TOC view developed by Goldratt and Cox (1984) as the sum of the local optimums is not equal to the global optimum. This, as supported by both of the theories, provided a direction for defining the unit of analysis of this study as supply chain, rather than an individual organization.

- *Sustainability-orientation in risk management strategies for achieving TBL-oriented goal can only be achieved with the involvement of all related supply chain members in strategy development process*.

3.2.4.3.2. Sensitivity to Changes

Chaos is a metaphor to describe how a major effect can be generated by a minor change in a system; holding the idea of butterfly effect (Wilding, 1998), or in terms of supply chains, the bullwhip effect (Forrester, 1961; Lee, Padmanabhan and Whang, 1997). Thus, small changes in initial conditions produce great impacts on the behavior and evolution on the entire system. Therefore, any system constraint, that is, any risk factor in supply chain logistics operations that causes sustainability-related hazards, would limit the performance of a supply chain, and prevent it from achieving to its TBL-oriented goal. This constraint would amplify exponentially and generate chaos in the market side, if not prevented. Especially, in food chains, even minor changes in initial conditions might produce great impacts on the market side, which may threaten human health, and thus social sustainability. Therefore, by using chaos theory, the proposition of TOC is complemented; and, when combined with the focus of this study, a major proposition for the theoretical model of this study is proposed:

- *Any risk factor in supply chain logistics operations that causes sustainability-related hazards would limit the performance of a supply chain, and prevent it*

from achieving its TBL-oriented goal, which may arise at initial stages, then might be amplified exponentially and cause chaos at later stages.

3.2.4.3.3. Core Conflict and Underlying Mechanism

One of the main issues in chaos theory in relation to marketing systems is the challenge related to detecting the core element of the chaotic behavior in marketing systems. Therefore, it is vital to investigate the underlying mechanism which causes chaos in marketing systems. This underlying mechanism causing chaos can be defined as the core conflict, which prevents the performance of the system achieving its goal, as similarly stated by TOC. This, offers for another opportunity to combine the views provided by TOC and chaos theory, and explains the theoretical framework of this study.

- *The underlying mechanism causing chaos is the core conflict related to risk factors in supply chain logistics operations, that are the common causes of sustainability-related hazards for all three dimensions (economic, environmental, social).*

3.2.4.3.4. The Concept of Continuity

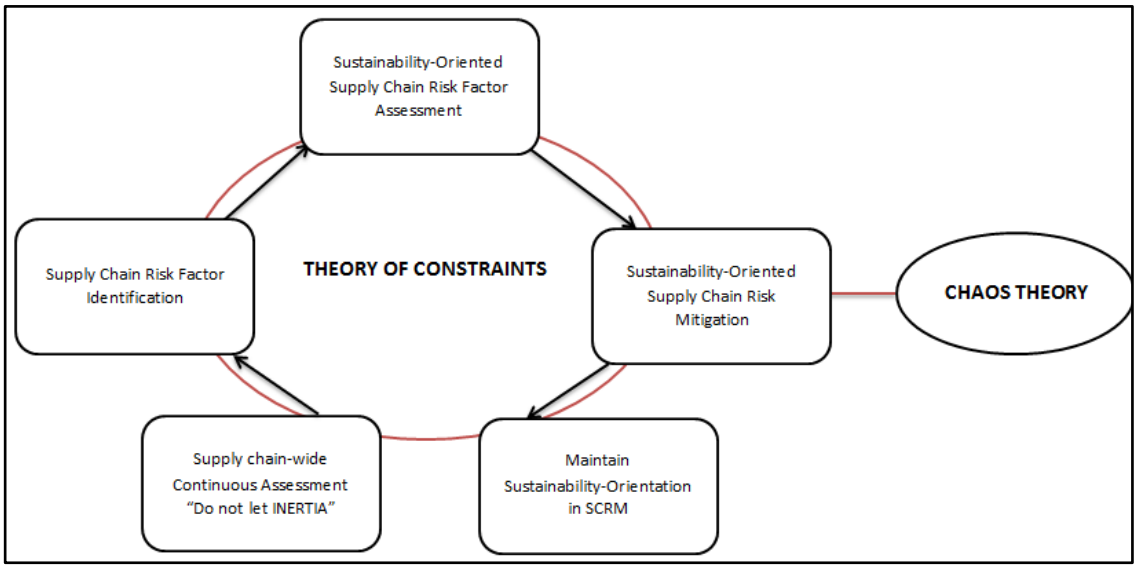
The idea of continuity in chaos theory is also a premise of TOC, which highlights the importance of avoidance of the inertia factor. Therefore, both from a TOC point of view and chaos theory perspective, continuity is the ultimate factor for avoiding inertia and maintaining change. This, when considered from the focus of this study, offers for another proposition.

- *Sustainability-orientation in supply chain risk management strategies for achieving TBL-oriented goal of businesses should be maintained through supply chain-wide continuous assessment – Do Not allow INERTIA*

3.3. THEORETICAL MODEL OF THE STUDY

Based on the above discussions, the theoretical model of the study is developed with the fundamental framework oriented around TOC, and supported by the chaos theory (Figure 4).

Figure 4: Theoretical Model of the Study



Source: Created by the Author

This model shows how the thinking process of TOC can be adopted from a sustainability and risk perspective; thus providing a roadmap towards building a sustainability-oriented supply chain risk management framework. The combined propositions offered by TOC and chaos theory, in the above discussions, are also made clear in the model.

In the model, the evolving and inevitable trend of marketing related to sustainability based value creation in order to avoid social, environmental and economic losses for future generations (Charter et al., 2006; Krysiak, 2009) is explicitly addressed, with an aim to ensure superior customer value by achieving desired levels of satisfaction and gain competitive advantage in the market.

This theoretical model is taken as the fundamental guide in this thesis study while progressing through the research steps to achieve to the main purpose.

The supply chain risk identification phase in this theoretical model is addressed in the next section through the arguments based on the constraint propositions explained by several theories. It has accordingly been argued whether the constraint assumptions offered by the theories address and explain risk factors in supply chains.

3.4. IDENTIFICATION OF SUPPLY CHAIN RISK FACTORS FROM A GENERIC PERSPECTIVE

Theories offer different approaches to understand, explain, and predict systematic reasons for a particular case supported by convincing and logical arguments (Sutton and Staw, 1995). Theories are constructed through the identification of major concepts and phenomena, and reasons for the propositions offered by logical arguments. Therefore, it could be stated that, fundamentally, theories seek to provide logical explanations (Babbie, 2010). Every theory has different assumptions, propositions, explanations, accepted principles, and rules of procedures (Weick, 1995), sometimes distinctive from each other, sometimes complementary. Those assumptions and arguments in the theories addresses to fundamental propositions, providing valuable ground and directions for scientific explanations. In the arguments of theories, there exists an inherent constraint identified for explaining the edge of what that theory focuses on. That constraint would be a problem or an obstacle of which the theory is constructed to explain.

What is argued to address the first research question of this thesis study is that, those constraints inherently offered by the theories, address to causes of risks. Therefore, exploring risk factors from related theories in the field could provide a generic path for building a theoretical framework to risk management as well. Besides, it has already been recommended to combine or transfer different theories in the area of sustainability to provide insightful analysis (Winter and Knemeyer, 2013). Therefore, this viewpoint, when applied to supply chain risks, can also suggest a

direction in developing a generic classification of risk factors from a sustainability framework.

3.4.1. Constraint Propositions Inherent in Theories

While reviewing the literature for developing the theoretical background of this study, theories related to the fields of theoretical focus were outlined covering the field of supply chain management, risk management and sustainability. The theories primarily outlined were; Agency Theory, Institutional Theory, Stakeholder Theory, Contingency Theory, Resource Based View, Dynamic Capabilities, Natural Resource Based View, Resource Dependence Theory, Population Ecology, and Transaction Cost Economics (e.g. Halldórsson et al., 2007; Ketchen and Hult, 2007; Zsidisin, Voss and Schlosser, 2007; Ellram, Tate and Billington, 2008; Trkman and McCormack, 2009; Sarkis, Zhu and Lai, 2011; Chicksand et al., 2012; Connelly, Ketchen and Hult, 2013; Hoffmann et al., 2013; Morali and Searcy, 2013;). Accordingly, the constraint propositions inherent in these theories were outlined to develop a generic framework for sustainability-oriented supply chain risk management.

Despite the variation in theories related to these three fields of focus (supply chain management, risk management and sustainability), only the theories addressed relatively more frequently in the literature are considered within the scope of this analysis, in order to explain the concept of the identification of generic supply chain risk factors.

Besides, each theory covers various constraints in their explanations. Here, the constraints which are emphasized in basic assumptions and propositions are primarily considered within this scope. Therefore, this framework can be extended towards other theories or other constraints in future studies as well.

3.4.1.1. Constraint Proposition in Agency Theory

The origins of agency theory rely on economic concerns (Ross, 1973), where principals and agents seek for their own utility within their interest area (Cuevas-

Rodriguez, Gomez- Mejia and Wiseman, 2012). Agency theory models the agency problem as a means of relationships between a principal (who delegates the work), and an agent (who performs the work) by considering the concepts of compensation, risk and information systems (Eisenhardt, 1988). As the interest of agency-principal diverges, the main aim here is to decide on the optimal contract (Jensen and Meckling, 1976; Hill and Jones, 1992; Tate et al., 2010) to govern the relationship between the principal and the agent. In this framework, two main scenarios determine the structure of the contract; a certain or an uncertain situation on the actions of the agent in terms of the principal. A risk situation arises in both cases, but the way the contract should be concluded, or behavior oriented changes, depend on whether the situation is certain or uncertain. Thus, the fundamental concern of agency theory, which maintains the structure of the contract and the dynamics between the principal and the agent, is based on the assumption of self-interest (Eisenhardt, 1988; Hill and Jones, 1992) leading to goal conflict, hidden information and risk aversion. In such a situation, in case of unanticipated events, actors will each behave in the interest of their company or functional area. This self-interested behavior of the agents affects the behavior of the principal as well as the outcomes.

Therefore, *self-interest* can be considered as a fundamental constraint in principal-agent relationships, and as the basic constraint proposition offered by agency theory within the scope of this study.

3.4.1.2. Constraint Proposition in Institutional Theory

Institutional theory emphasizes homogeneity, isomorphism and adaptive change as the three forms of pressures on organizations to conform to their expectations. Institutional theory formulates compensation policies so as to manage industrial dynamics and relationships. Institutional theory suggests that commonly accepted policies and norms translate organizational members, their structures and processes into an isomorphic format (Eisenhardt, 1988). Yet the isomorphism assumption of institutional theory still challenges the globally dispersed organizations surrounded by highly uncertain environments and highly dynamic nature in diverse settings (Kostova, Roth and Dacin, 2008). Coercive pressures arise

from societal expectations and inter-organization interdependence; normative pressures arise from professionalization; and mimetic pressures derive from uncertainty in environment (DiMaggio and Powell, 1983). As organizations in the same field are subject to similar coercive, normative, and mimetic pressures, they tend to develop similar sets of administrative structures (DiMaggio and Powell, 1983). For this reason, institutional pressures result in organizational homogeneity (Scott, 1995). Organizations become increasingly similar, and shift towards isomorphism through several institutional forces, by confronting norms, rules, values and beliefs for improving their survival, legitimacy, and thus performance. (Scott and Meyer, 1982; DiMaggio and Powell, 1983; Kondra and Hinings, 1998). This is a risk-minimizing shift for organizations (Baum and Oliver, 1991). By adopting structures that conform to institutional requirements, organizations demonstrate their conformity to social norms, and thereby garner legitimacy for their operations. Legitimacy refers to whether organizational actions are accepted and approved by internal and external stakeholders. Organizations adopt consequentially through the process of progress. However, the degree of institutionalization differs between interacting organizations depending on their different capabilities (Selznick, 1957).

The arguments of institutional theory offer for a new constraint that can be considered as the constraint proposition inherent in institutional theory, which is *isomorphism to garner legitimacy* (Scott, 1987; Scott, 2004; Scott, 2008; Lin and Sheu, 2012).

3.4.1.3. Constraint Proposition in Stakeholder Theory

In stakeholder theory, the main concern is to explain the dynamics of relationships between different groups of people resulting from different levels of interactions and inevitable change. This brings moral concerns to the fore. Avoiding a failure in moral endeavor therefore becomes a major concern for creating long term benefit and value (Parmar et al., 2010). Stakeholder theory holds the concepts of morality and ethics in business organizations explicitly as a central concern by considering the relationships and interactions of people and groups of people, which affect the whole organization as well as the businesses (Phillips, Freeman and Wicks,

2003). Stakeholder theory is comprehensively articulated by Freeman (1984) in his book *Strategic Management: A Stakeholder Approach*. With a specific emphasis on the environmental shifts occurring worldwide, his primary point was on the stakeholders' important role, and, its influence in achieving superior performance and value creation. From a stakeholder perspective, business can be understood as a set of relationships among groups that have a stake in the activities that make up the business (Freeman, 1984). Laplume, Sonpar and Litz (2008) cite the concepts related to ethics, fairness, rights, religion and pragmatics as forming normative foundations of stakeholder theory.

Thus, it represents a moral endeavor because it concerns questions of values, choice, and potential harms and benefits for a large group of groups and individuals (Phillips, Freeman and Wicks, 2003; Parmar et al., 2010). Therefore, the constraint proposition offered by stakeholder theory can be identified as *morals, values and ethics*.

3.4.1.4. Constraint Proposition in Contingency Theory

Contingency theory posits the concept of fit in terms of the organizational context, structure and processes, which holds the idea of Dubin's law of interaction (Dubin, 1976; Drazin and Van de Ven, 1985). Contingency theory contravenes a single best alternative assumption for managing organizations, making decisions and performing leadership, and holds the idea of situational factors leading to different outcomes in different settings (Lawrence and Lorsch, 1967). Thus, a fit in organizational structure, processes and environment is necessarily important for performance and value creation (Flynn, Huo and Zhao, 2010).

Therefore, the constraint proposition explored by contingency theory can be identified as *alignment and fit to environment*.

3.4.1.5. Constraint Proposition in Resource Based View

In resource based view, firms are evaluated based on their internal capabilities and considered as bundles of resources which might be assets, such as

physical, human, organizational or local abilities and competencies to help the firm to adapt value-creating strategies (Eisenhardt and Martin, 2000, Barney, 2001). A resource-based view focuses on the internal organization of the firm, and deals with those resources which are heterogeneous to every firm. The main concern is to outline how competitive advantage can be achieved or sustained through the value created by those resources. Therefore, the resources that are valuable, rare, inimitable, non-substitutable, and cannot be easily duplicated by competitors, help firms achieve better sustainable competitive advantage than others (Eisenhardt and Martin, 2000; Barney, 2001; Halldórsson et al., 2007; Barney, Ketchen and Wright, 2011).

The constraint extracted from resource-based view is related to the resources that need to be differentiated to achieve and sustain competitive advantage. Therefore, *differentiated resources* are identified as the constraint proposition related to this theory.

3.4.1.6. Constraint Proposition in Dynamic Capabilities

Dynamic denotes change. In dynamic markets, the rules of competitiveness are too fragile to be transformed into new forms immediately. Therefore, it becomes necessarily important for firms to integrate both internal and external resources, and thus capabilities, to this world of rapidly changing environments to achieve competitiveness. Besides, those capabilities need to be built and reconfigured continuously to improve their performances and sustain their competitive advantages. In such an environment, the principles of resource-based view are not adequate to explain such dynamics in situations of rapid and unpredictable change, in terms of the firms seeking for competitive advantage. This is where dynamic capabilities theory is proposed as an extension of resource-based view for dynamic markets (Eisenhardt and Martin, 2000; Luo, 2000; Winter, 2003; Ambrosini, Bowman and Collier, 2009).

Therefore, the constraint within dynamic capabilities is closely related to improving the capacity to change, integrate, reconfigure, release and adjust the resource bases of firms in order to match the dynamism of the markets and the

environment. Based on those, the constraint proposition explored by dynamic capabilities theory can be identified as *resource configuration*.

3.4.1.7. Constraint Proposition in Natural Resource Based View

Natural resource based view also benefited from the framework provided by dynamic capabilities (Hart and Dowell, 2010). The main argument of resource based view lies in the firm's relationship to the natural environment. The focus is on the capabilities that contribute to environmental activities for achieving and sustaining competitive advantage (Hart, 1995). It is discussed in this view that the main limitation is rooted in ecosystems which will eventually affect the activities and sustainability of the businesses and the markets. Therefore, this challenge associated with the natural environment is necessarily important to be incorporated in strategic management (Hart, 1995; Michalisin and Stinchfield, 2010), and any omission of natural environment would result in a serious constraint for sustainable competitive advantage (Hart and Dowell, 2010).

The link between the resources, capabilities and strategic outcomes, provided within the arguments of natural resource based view, suggest a relationship between the environmental and financial performances. Therefore, the constraint proposition inherent in natural resource based view is outlined to be *environmental sustainability*.

3.4.1.8. Constraint Proposition in Resource Dependence Theory

Resource dependence theory argues that organizations, as being open systems, are dependent on external contingencies. Others, that those organizations are dependent on, have a power over them, which impel organizations through environmental interdependencies covered by uncertainties (Pfeffer and Salancik, 1978; Paulraj and Chen, 2007; Hillman, Withers and Collins, 2009). Within this perspective, resource dependence theory seeks to explain the ecology of organizations, those environmental interdependencies and uncertainties surrounding the organizations, and aims to reduce their power over them. Therefore, central to this theory, there is the concept of power. Organizations struggle to control vital

resources and reduce others' power over them, while increasing their own power (Paulraj and Chen, 2007; Hillman, Withers and Collins, 2009).

Therefore, the constraint proposition here is explored as the *interdependencies with other organizations and uncertainty in their actions*.

3.4.1.9. Constraint Proposition in Population Ecology

Population ecology examines the populations of organizations. This theory proposes that organizations need to adapt to changes in their environment, and that their survival is strongly based on their environmental selection that best fits to their local environment. Therefore, population ecology suggests that adaptive change towards a best fit environment is essential for organizations to survive (Hannan and Freeman, 1977; Carroll, 1984; Crook and Combs, 2007; Salimath and Jones III, 2011). However, there exist a number of factors that restrict the ability of organizations to adopt and evolve. These limiting factors in relation to various processes generate structural inertia. Such inertial pressures generated either through internal structures or through environmental constraints, especially when these are stronger, force down the organization's adoptive flexibility and environmental selection (Hannan and Freeman, 1977; Carroll, 1984). This addresses to the principle of isomorphism. That is, when forced by inertial pressures, organizations resemble others with the same inertial pressures experienced. This reinforces organizations' tendency to develop a more standardized format of procedures, and lead to structural inertia, which hinders organizations adaptation.

However, organizations which do not adapt, especially in cases where competition is harsh, are likely to fail (Crook and Combs, 2007). Within this perspective, the constraint proposition extracted from population ecology is identified as *adaptation*.

3.4.1.10. Constraint Proposition in Transaction Cost Economics

From the transaction cost economics perspective, organizations are explicitly viewed as governance structures (Shelanski and Klein, 1995; Rindfleisch and Heide,

1997; Williamson, 1998). Organizations seek to minimize transaction costs and safeguard themselves against other trading partners, with which they are subjected to an exchange relationship. Transaction cost economics studies how the potential hazards associated with those exchange relationships could be minimized and safeguarded to avoid any damage in their performances (Shelanski and Klein, 1995; Chiles and McMackin, 1996; Rindfleisch and Heide, 1997; Williamson, 1998; Halldórsson et al., 2007). The transactions behind those trading partners need to be governed, designed and realized, and best performance governance structures should be employed.

Therefore, transaction cost economics examines alternative institutions of governance as well. Within this framework, the constraint proposition offered by transaction cost economics is identified as *exchange relationship governance structure*.

3.4.2. Generic Supply Chain Risk Factors Outlined by The Theories

The constraint propositions offered by the fundamental argument of the theories addresses **Research Question 1**, which seeks to identify how supply chain risk factors can be identified generically. Within this framework, it could be stated that one risk factor associated with supply chains can be related to one or more constraint propositions inherent in given theories, depending on the reasons and triggers behind that risk factor. Therefore, it is suggested that supply chain risk factors should be explained by the constraint propositions of related theories to reach a consensus in classifying supply chain risks, and provide a theoretical framework to supply chain risk management.

The constraint propositions outlined by above theories are transformed into generic definitions of risk factors for supply chains in Table 1:

Table 1: Generic Supply Chain Risk Factors explored by the Theories

Theory	Constraint Proposition	Generic Supply Chain Risk Factors
Agency Theory	self-interest	self-interest
Institutional Theory	isomorphism to garner legitimacy	organizational heterogeneity
Stakeholder Theory	morals, values and ethics	immorality
Contingency Theory	alignment and fit to environment	organizational rigidity
Resource Based View	differentiated resources	resource similarity
Dynamic Capabilities	resource configuration	resource stability
Natural Resource Based View	environmental sustainability	environmental negligence
Resource Dependence Theory	interdependencies with other organizations/uncertainty in actions	interdependency
Population Ecology	adaptation	inertia
Transaction Cost Economics	exchange relationship governance structure	non-governance of exchange relationships

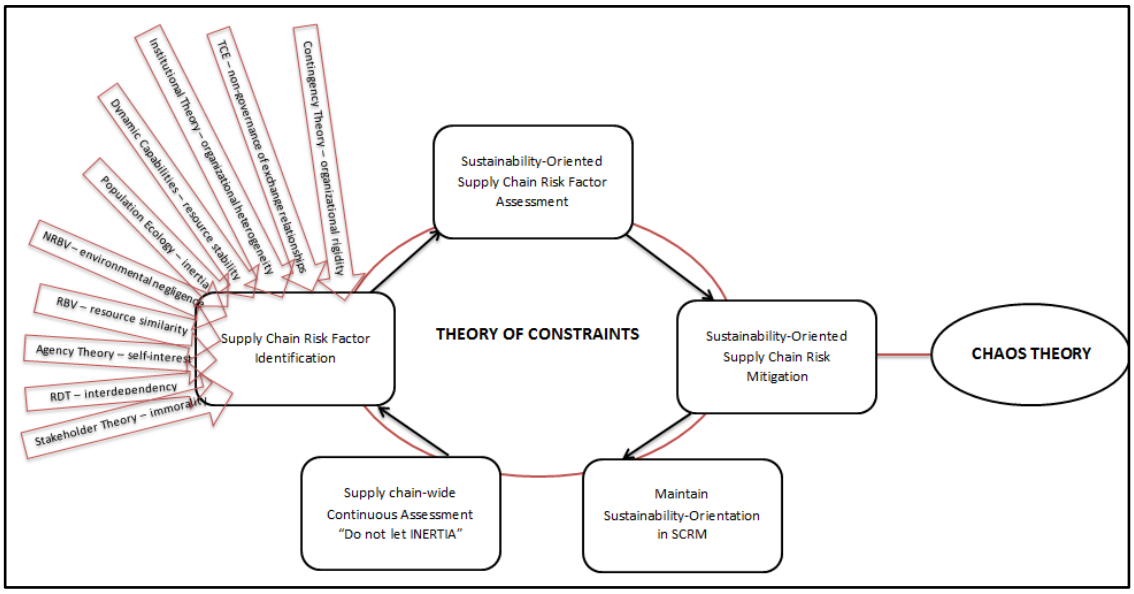
Source: Compiled by the Author

3.5. THEORETICAL MODEL OF THE STUDY WITH GENERIC SUPPLY CHAIN RISK FACTORS

The theoretical model of the study in Figure 4 is revised based on the risk factors outlined from the constraint propositions offered by the theories.

As presented in Figure 5, the constraint propositions explored from related theories address the first step of TOC, in which the supply chain risk factors were identified. This means that identified supply chain risk factors indicate primarily one constraint proposition offered by the theories, which would then be rendered into a generic definition to provide a logical explanation as well as a unique and theoretical framework to supply chain risks.

Figure 5: Theoretical Model of the Study with Generic Supply Chain Risk Factors



Source: Created by the Author

The reminder of the thesis presents the methodology and findings of the empirical research conducted in the study, which is founded on the theoretical discussions presented in the previous chapters.

The design of the research is built on the theoretical model presented in Figure 5, with the processes in the model addressing the research questions of the thesis.

CHAPTER IV
METHODOLOGY

After presenting the theoretical focus of the study and building the theoretical model with supply chain risks identified from a generic framework, the research process and scope was designed. As an outcome of the extensive literature review regarding the theoretical focus of the study, the gaps outlined by the articles (Figure 1) were then utilized while designing the multiple-case study and determining the research phases in the reminder of the study.

The research was designed in order to provide rich insights to the fundamental aim of the study, and therefore mixed methodologies at each phase of the study were utilized sequentially to address the questions of the research. The audience and the type of data necessary to explain these questions were significantly determined, to ensure that the methodologies were identified and applied in a true setting.

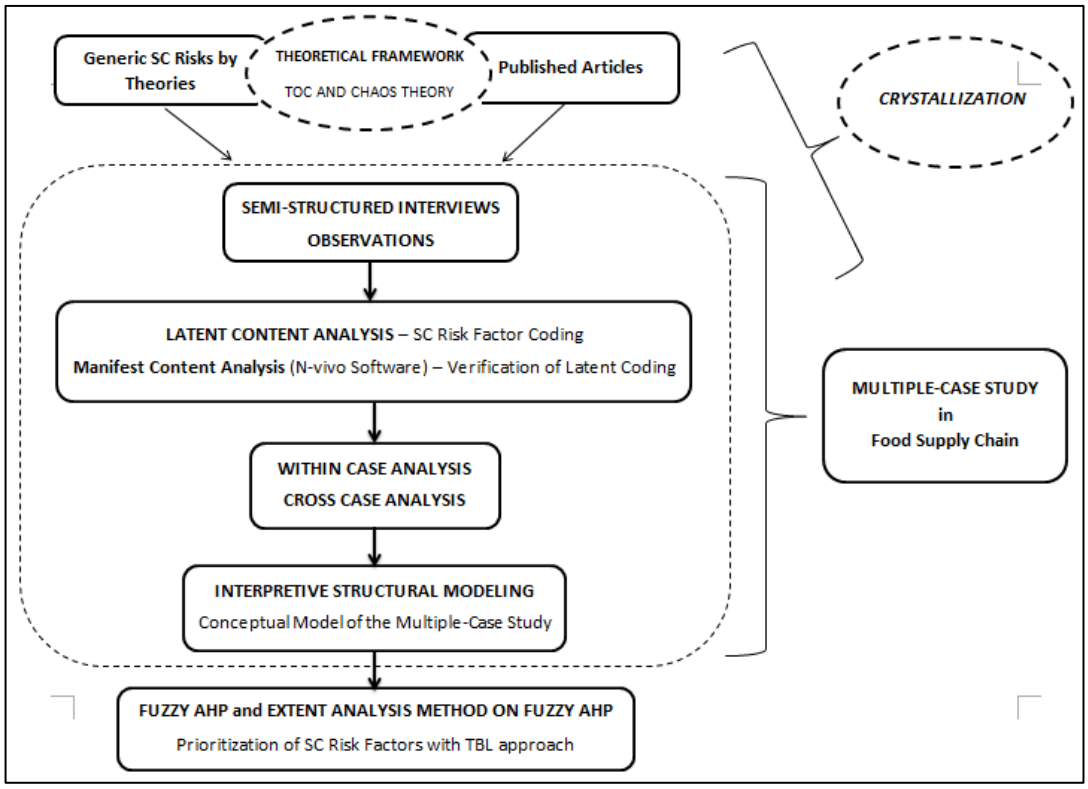
4.1. DESIGN OF THE RESEARCH

This research was fundamentally based on a multiple-case study, which was conducted in five different food chain types at different supply chain levels, with a specific emphasis given on cold logistics activities (Figure 6). The data in multiple-case study was collected through semi-structured interviews and observations, by which food supply chain risk factors were identified. The latent coding of the risk factors were identified by content analysis, based on the themes expressed during the multiple-case study. Those latent codes were then reviewed through manifest content analysis by NVivo software, which was conducted to outline the frequency of reference on the risk factors in the articles published in *web of science* database.

The findings were analyzed through within case analysis for each food chain type. The prominent risk factors expressed at each food chain type by each supply chain member were outlined. The findings of each case type were then compared by cross case analysis.

The interrelations and contextual relationships of those risk factors were outlined through ISM methodology, which were then used to arrive at the conceptual model of the research.

Figure 6: The Design of the Research



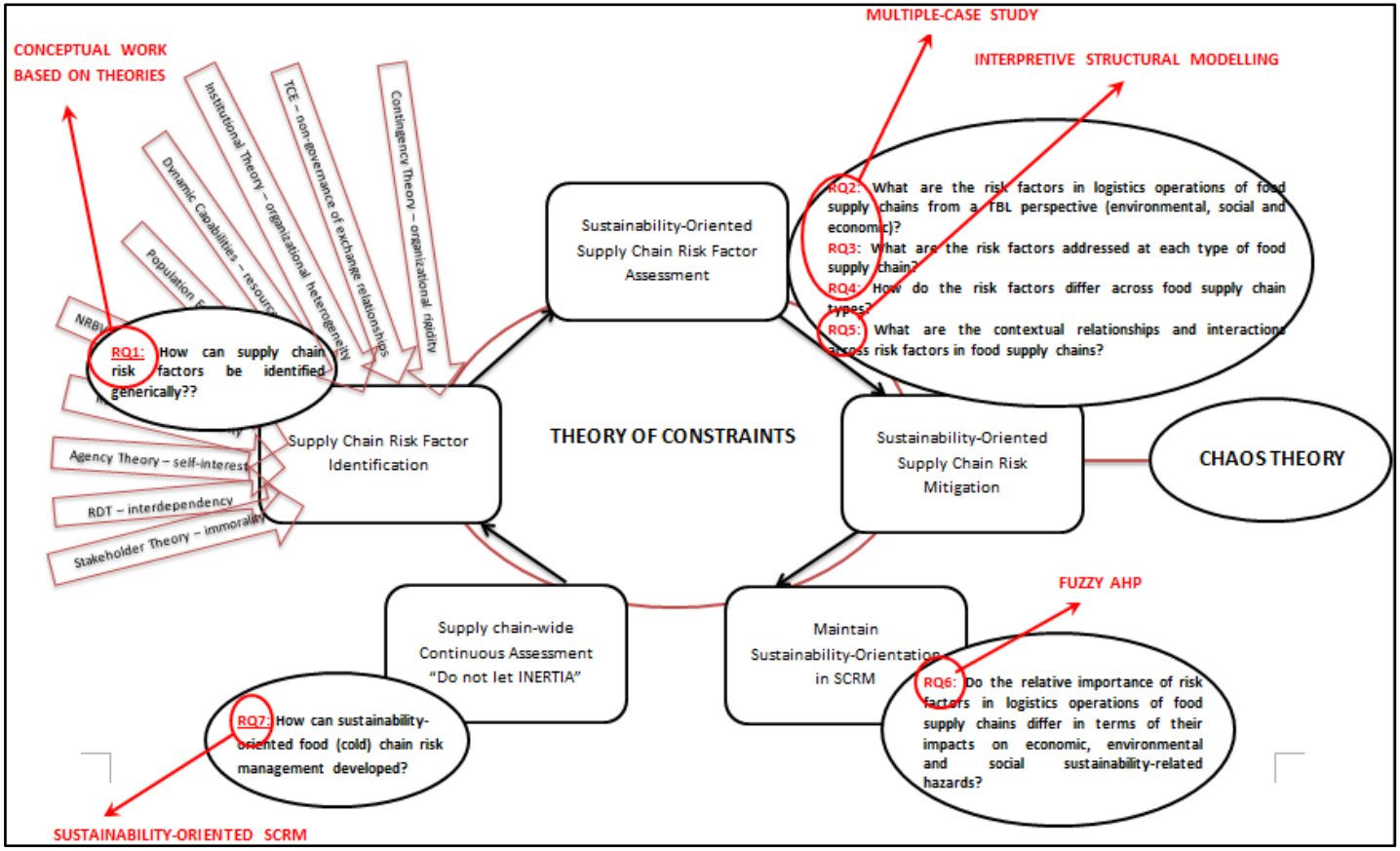
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In order to develop a sustainability framework on those risk factors, each risk factor group was prioritized through fuzzy AHP based on the extent of their impacts on environmental, social and economic sustainability-related hazards, distinctively. The prioritized risk factors for each dimension of sustainability were then compared in order to outline a sustainability-related supply chain risk management framework for food supply chains.

The theoretical model of the study shown in Figure 6 is adapted to this methodological perspective, and re-presented in Figure 7. Each methodological phase of the research is grounded on the purpose of the research, as well as on the

framework provided by the theoretical model of this study explained by the theoretical framework of TOC and chaos theory. In Figure 7, the research questions addressed at each phase of the study are also shown.

Figure 7: The Theoretical Methodology of the Study



Source: Created by the Author

4.1.1. Multiple Methodologies in Research

Research strategy is the overall approach to explore the phenomenon in focus, the plan or the roadmap, while the methods are the tools for conducting the research (Marshall and Rossman, 1995). Considering that each have different strengths and weaknesses, it is important, but also a challenge to decide whether to follow a qualitative, a quantitative or a mixed method. Here, it important to consider various aspects such as, the purpose of the research, audience necessary to explore the findings, the fundamental questions of research, the type of data, which would help to explain these questions, resources available and the criteria to judge the quality of findings. It is also important to recognize that qualitative and quantitative approaches are complementary approaches, rather than being in conflict (Jick, 1979).

4.1.1.1. Qualitative and Quantitative Approaches in Research Design

Quantitative research is used especially when there is a hypothesis or a theory to be tested for confirmation or disconfirmation, and the relationships among the variables are being examined (Newman, 1998; Creswell, 2009). Quantitative research methods collect numerically representable data in a systematic manner (Kirk and Miller, 1986), and are mostly derived from standardized questionnaires based on scales. Thus, quantitative data is systematic and standard, which is easier and more concise to interpret.

On the other hand, qualitative research is a naturalistic approach to the world which locates the observer in the natural setting of this world in order to interpret and explore the inherent meanings and representations of the related phenomena through field notes, interviews, conversations…etc. In qualitative research, the researcher is the key instrument for collecting multiple sources of data in words or images. Here, a holistic view of the social phenomena can be outlined by a specific focus on the participant's perspectives, meanings and subjective views.

Although in quantitative observation, the degree to which one feature is present is measured, in qualitative observation, the presence or absence of something is identified (Matthew and Ross, 2010). Therefore, qualitative research best suits in

cases where there is a complex issue to be understood, probed and explored. It also empowers participants to share their ideas, feelings, stories in their natural contexts and settings. Qualitative research is preferred especially in cases where the issue under investigation does not fit into a framework to be explained through quantitative measures or statistical analysis (Creswell, 2007). Qualitative research provides a path for exploring complexities and processes in-depth, and allows identifying informal and unstructured issues in organizations (Marshall and Rossman, 1995). In qualitative research methods, the primary concern is the stories, subjective understandings, feelings, opinions and beliefs (Matthew and Ross, 2010). Thus, while interpreting findings in qualitative research, it is necessary to evaluate behaviors, beliefs, perceptions or perspectives of the case, in order to explore a meaning from the interviews or observations (Kirk and Miller, 1986). On the other hand, qualitative findings are more detailed, variable and longer, as the responses are not systematic or standard. Thus, it is more complex to analyze.

Qualitative findings are explored through the data collected by in-depth interviews, direct observations or document analysis (Marshall and Rossman, 1995; Patton, 2002). As it is not possible to observe everything, sometimes there would be a need to explore information by asking people questions. This helps to enter into an individual's perspective in depth. This interview can be organized in an informal conversational format, in which questions are spontaneously generated during the natural flow of interaction, or in a format of a general interview guide, in which a checklist of questions are listed according to the points to be explored in advance, or in standardized open-ended interview format, in which same questions are asked to the respondents in sequence (Patton, 2002). Although standardized open-ended interview limits the opportunity for a deep probing, in some cases, in which the interviews depend on the interviewer, it helps to minimize the variations in the answers of the respondents. The interviewer can select one interview format or combine several. Especially, using standardized open-ended interview format at the beginning of the interviews, and then leaving the interview to an informal conversational format would help both to provide answers to specific sets of questions and also to freely discuss and probe additional perspectives of the interviewee in some specific cases. While listing the questions of the interviews, it is

important to ask questions that explore the opinions, feelings, sensory information of the respondents, or that help to understand the background of the respondents, their demographic features, behaviors or the underlying reasons for their behaviors (Patton, 2002). Here, it is important to keep neutrality while establishing rapport with the person under interview (Patton, 2002).

In interviews, it is critically important to report every detail during the interview process which reflects the perspective of the interviewee. Therefore, verbatim responses of respondents are recorded by a tape record, and this record is also supported by the notes taken during the interview (Patton, 2002). Besides, as the interview takes place in the natural living or working environment of the respondent, the ethical framework of the interviews, as well as informed consent and confidentiality are important aspects while planning and conducting for an interview (Patton, 2002).

As explained, in in-depth interviews, open ended questions are asked in order to probe and understand one's points of view in details and explore an issue. In interview research, emotions, perceptions, ideas, feelings, knowledge, experience and world view of people is probed in-depth, and a detailed understanding on the subject of research is developed. However, there are of course limitations as to what can be explored from people's words. In order to solve the complexities of such certain situations, direct observation of the phenomenon would help to develop a comprehensive understanding. In order to develop a comprehensive insight to an issue, it is necessary to be in and around the social setting, and experience it personally. Therefore, fieldwork, or namely direct observation, is important in conducting qualitative research. In field-based observations, the researcher can observe a detail that has not been recognized before. Besides, it avoids the researcher relying on prior conceptualizations, and outlines some notes that many people are reluctant to talk in an interview. People clearly have selective perceptions coming from their culture, background, biases…etc. Through fieldwork, the researcher can go beyond those selected perceptions, and report some points that cannot be outlined in the interviews. Moreover, and perhaps the most critically, through fieldwork, the researcher experiences the setting personally and becomes the part of research data,

which then provides a better evaluation and interpretation of the findings (Patton, 2002).

4.1.1.2. Mixing Qualitative and Quantitative Approaches

Other than using qualitative or quantitative methodologies, another choice is to utilize mixed methodologies (Creswell, 2009). Some researchers prefer to apply mixed methods which combine qualitative methods with quantitative methods. This decision on whether to select mixed methods in the research design comes from how best the research questions of the study can be answered (Matthew and Ross, 2010). The concept of mixing methodologies was first raised by Campbell and Fisk in 1959 (Creswell, 2009). The main rationale behind using multi-methods is related to the existence of limitations of each method to be covered by utilizing another method. Besides, use of different methodologies would also merge into large volume of data, reinforcing the findings of one another.

Mixed methods might be utilized in three forms; sequential mixed methods, concurrent mixed methods, transformative mixed methods. In sequential mixed methods, the aim is to elaborate or expand the findings of one method with another. It might either start with a qualitative method followed by a quantitative one, or vice versa. In concurrent mixed methods, the aim is to collect qualitative and quantitative data and merge them to provide comprehensive analysis. On the other hand, in transformative mixed method, the aim is to use a theoretical lens while collecting data by both qualitative and quantitative methods (Creswell, 2009).

4.1.2. Multiple Methodologies Employed in this Study

This study is designed as a two-phase, sequential mixed method. The intent of this two-phase, sequential mixed methods study is to develop a sustainability-oriented risk management framework in supply chains. The first phase will be a qualitative exploration of supply chain risk factors from a TBL sustainability approach. In this part, qualitative data is collected through semi-structured interviews and observations from various types of supply chain members, including the

consumers, in a case study format, conducted within five different types of food supply chains. Findings from the qualitative phase are then used to prioritize supply chain risk factors, based on the level of their impacts on environmental, social and economic sustainability-related hazards through fuzzy AHP methodology. AHP is a multi-criterion decision-making (MCDM) methodology, applied to qualitative parameters, which helps to convert pair-wise comparisons into numeric forms of values.

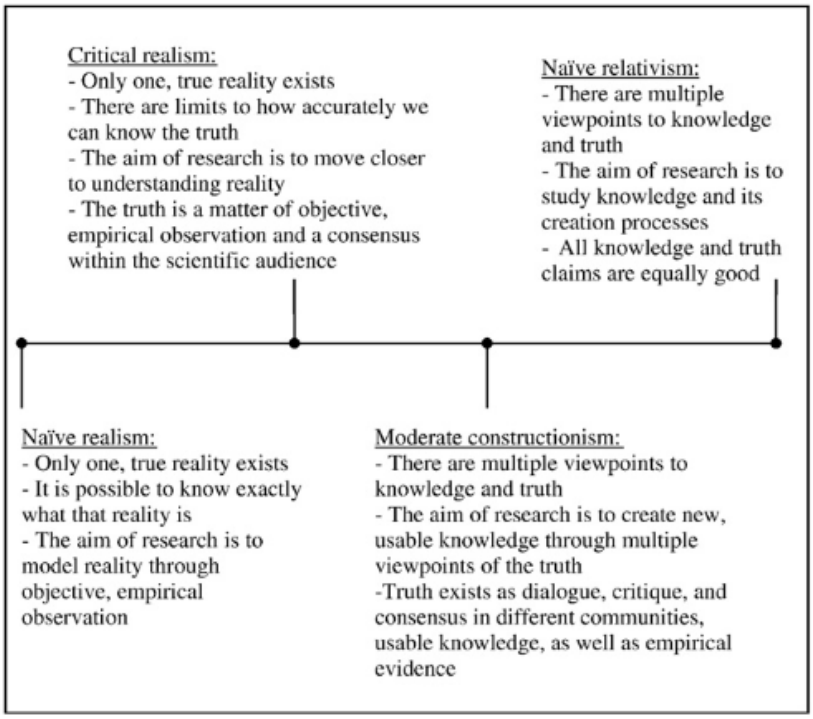
The purpose for collecting qualitative data initially is first to explore and generate risk factors about food supply chains. The rationale for using both qualitative and quantitative data was that a useful approach could best be developed only after a preliminary exploration of supply chain risk factors through interviews and observations. Later, by transforming qualitative data into quantitative form using a fuzzy AHP framework, the analysis on prioritization would be possible. Besides, the findings of the two approaches would also merge and reinforce each other to provide a better analysis on the research problem. This also provided an opportunity to elaborate or expand the findings of one method with another (Creswell, 2009).

4.1.3. Different Approaches in Nature of Research

To build a sufficient level of quality in the qualitative part of this research, eight basic conceptualization criteria proposed by Tracy (2010), namely worthy topic, rich rigor, sincerity, credibility, resonance, significant contribution, ethical and meaningful coherence, is followed during both the design phase and throughout the study.

Case studies provide a multidimensional view by capturing various dynamics of the phenomenon in research scope, and are a suitable method for exploring and understanding the holistic context of business networks and relationships in different settings, especially when considered from the view of marketing (Eisenhardt, 1989; Halinen and Törnroos, 2005). In case studies, different views can be involved, ranging from ontological, epistemological and methodological perspectives, lying on a continuum from naive realism to naive relativism as shown in Figure 8 (Lincoln and Guba, 1985; Easton, 2002; Järvensivu and Törnroos, 2010).

Figure 8: Continuum of Ontological and Epistemological Worldviews



Source: Järvensivu and Törnroos, 2010

Naive realism and naive relativism stand at two opposing poles; naive realism is an extreme form of positivism, which argues that one true reality (objective reality) exists and this can only be explored through objective and empirical observations, whereas naive relativism is an extreme form of constructivism, which argues that there are multiple interacting realities (subjective reality) which can vary depending on the community of focus (Jarvensivu and Törnroos, 2010). Critical realism and moderate constructivism stand in the middle. Critical realism holds a post-modernist paradigm, arguing that there is a reality independent of our knowledge that can be explored through observations in terms of epistemology, which moderate constructivism rejects the universal truth insisted on by the positivists, and accepts the possibility of a specific, community-based form of a knowledge that can be explored through empirical data.

Moderate constructivism is proposed as an alternative to critical realism, especially in research designed by the case studies (Jarvensivu and Törnroos, 2010).

Despite critical realism and moderate constructivism both sharing the same ontological and epistemological grounds, and both holding the same argument that rational and social aspects of knowledge do exist, moderate constructivism is more concerned about the possibility of community-based knowledge depending on the researcher who conducts the research, as well as on the research subjects (Jarvensivu and Törnroos, 2010). This is due to the fact that realist position argues objective observations of reality exist, whereas relativist position argues observations are bounded by subjectivity. In Jarvensivu and Törnroos (2010)'s paper, moderate constructivism is offered as an alternative perspective to critical realism in case studies, especially in the marketing field. Because, especially in terms of the methods of interviewing, where knowledge is constructed through the involvement of interacting active parties of the social encounter (the interviewee and the interviewer), from a moderate constructivist approach, the interviewer is mostly concerned about valid and reliable information being probed and explored from the informant's mind, by eliminating any potential biases and misunderstandings. Thus, different from critical realists, who triangulates the truth through empirical evidence, moderate constructivists crystallizes different community-restricted forms of knowledge. Although moderate constructivism is an approach based on single case studies, multiple-case studies can also be based on moderate constructivism. From a moderate constructivist viewpoint, neither single nor multiple case studies should be evaluated in terms of the generalizability of their findings; rather, they should be evaluated in terms of how well local and historically context-specific understanding is generated, and how well their findings contribute to contextual insights (Jarvensivu and Törnroos, 2010).

4.1.3.1. Crystallization as an Approach beyond Triangulation

Triangulation and crystallization are different approaches to empowering the validity of results, as accuracy in research is increased through the consideration of multiple viewpoints. Triangulation was first coined by Denzin (1978) as being an approach and methodology enabling cross validation in research. Triangulation, which is the combination of different methodologies on the same study of focus,

provides rich and comprehensive content on a problem, and encourages productive research. It allows for a complementary framework across different methods, and would be very effective in examining the same dimension of a research problem through combining the power of different methods, especially when providing a full framework by a combined use of qualitative methods and quantitative methods (Jick, 1979).

Despite its comprehensive framework, in constructionist research, validity needs to go one step beyond the approach provided by triangulation. In this approach, triangle is replaced by a crystal, which combines and integrates various methods to probe the research problem in focus and offers for the use of different methods to validate findings and provide a deeper understanding of complex issues. Therefore, in constructionist research, crystallization, rather than triangulation, is proposed as the central metaphor for validity (Richardson, 2000; Tracy, 2010).

4.1.3.2. Abductive Reasoning in Research

Moreover, the research process differs in realist and relativist views. Naive realists start by building a theoretical framework and follow a deductive research process combined with empirical observations, whereas naive relativists inductively build theory (Jarvensivu and Törnroos, 2010). In induction, the major aim is to develop theory through empirical observations for making generalization and allowing for transferability of results, whereas in deduction, the aim is to test or evaluate theory based on the theoretical framework provided. Critical realists and moderate constructivists mostly follow abduction, a method first proposed by Peirce in 1931 positioned in between induction and deduction. Differently, in abduction, the major aim is to develop a new understanding for providing future suggestions for theories, paradigms and other tools by deviating from theory. In abduction, neither pure deduction nor pure induction is followed (Taylor et al., 2002; Kovács and Spens, 2005). Different from induction, it accepts existing theory, and different from deduction, it mostly allows for a data-driven theory generation, rather than a theory-driven research process. In abduction, research processes might involve a mix of inductive, deductive and abductive sub-processes, with a different focus at any of the

phases (Kovács and Spens, 2007; Jarvensivu and Törnroos, 2010). In this respect, abduction is considered to be a very creative research approach, which provides a ground for understanding new phenomenon (Kovács and Spens, 2007), and also a suitable approach especially for case studies in business network research (Dubois and Gadde, 2002) or in logistics research (Kovács and Spens, 2005).

In case studies, the focus of concern is not to generate universal truths, but to generate local and specific understanding. Different from critical realism, generalizability in moderate constructivism relates to community acceptance of transferred theories. Considering the framework covered by moderate constructivism, for generalizability in research, selection of cases, especially through a theoretical framework, becomes a critical component of research (Jarvensivu and Törnroos, 2010).

4.1.3.3. About the Nature of This Research

The data in this study is collected and analyzed from a moderate constructivist viewpoint, meaning that the sustainability and risk issues in food chains are probed and analyzed to develop a deeper understanding on the focus of the study, as constructed by the community itself. Chaos theory is also compatible with the postmodern paradigm, as it assumes complexity and diversity of experience, and questions deterministic positivism (Levy, 1994; Murphy, 1996).

First, the theoretical framework is generated through an extensive review of the literature regarding the subjects in scope. Rather than focusing to reach to a single truth as in realist position, different viewpoints are considered in the analysis through the use of archival data on the area combined with the data collected by the different interviewees at different positions in various food supply chains, as well as through the observations at multiple sites. Thus, the research followed an abductive logic, in which theoretical framework is combined and integrated with the empirical framework provided by the multiple-case study. The collection of in-depth, extensive interviews and observation data through the multiple-case study is analyzed through latent content analysis, in order to identify the main risk factors expressed by the respondents. Although interviews are good methods for focusing directly on cases

topics and providing rich insight on perceived causal inferences or explanations, there is a risk of response bias, especially due to poorly articulated questions, and risk of reflexivity, in which the interviewee gives the answers that the interviewer wants to hear, and also risk of inaccuracies due to poor recall (Yin, 2009). Especially, when the subject of research is risk in food supply chains, this bias might become a threat which causes the findings to be misleading. Therefore, by interviewing different members from different levels of various types of food supply chains, it is aimed to ensure the findings are free from social desirability bias, which could be provided by the participants' answers and perspectives created in a direction to favor the researcher, rather than purely presenting the current situation (Crowne and Marlowe, 1960).

4.2. MULTIPLE-CASE STUDY IN FOOD SUPPLY CHAINS

It is important to identify and to justify the method selected for the specific research subject. Experiment, survey, archival analysis, history and case study are different methods used in different research contexts. The research methods are selected based on the forms of the questions of the research, the necessity of control on a behavioral event or the subject of focus of the research. First and foremost, the types of research questions define the research method which is applicable for the research problem. The use of mainly, 'what' questions might either be exploratory, by which any of the five methods can be used (including the case studies), or prevalence by which survey or archival data is favored. The 'how' and 'why' research questions are basically explanatory, and are more frequently conducted through case studies, histories and experiments (Yin, 2009).

Considering that the research questions of this study are mostly based on 'what' and 'how' questions, the case study approach is determined to be more applicable in order to address the problem under consideration. Of course, this framework provides a direction for avoiding gross misfits, but it does not imply that there are sharp boundaries in distinguishing between the methods to be used (Yin, 2009). Thus, it is further necessary to justify why conducting a case study methodology is more applicable in this research setting.

Case studies are currently widely used in logistics research, as they provide a path for revealing the causal depth for logistics activities (Aastrup and Halldórsson, 2008). On the other hand, case study is the second used method in the field of sustainability, as it is a new area of research, and the concepts or issues related to the field need to be explored and understood a priori (Seuring, 2011; Ashby, Leat and Hudson-Smith, 2012; Hassini, Surti and Searcy, 2012). Case study approach is also considered to be highly relevant for applying TOC concepts into business problems, which require a close observation and interaction with real life situations (Oglethorpe and Heron, 2013). In supply chain risk management research, the need for more conceptual works and case studies with close collaboration of the industry has been highlighted by Sodhi, Son and Tang (2012). On the other hand, case study is a highly applied methodology in the area of food chains (Rajurkar and Jain, 2011).

The case itself is a complex entity surrounded by different contexts, such as cultural, physical, social, economic, political or ethical. Although each case is singular, it involves different subsections, groups, occasions, dimension and domains with different contexts as well. Therefore, qualitative research deals with examining these complexities (Patton, 2002; Stake, 2005). Cases are units of analysis, mostly determined at the design phase of the study. In case study approach, comprehensive, in-depth and systematic information is collected from each case, then data is organized and analyzed. In case studies, theoretical propositions guide data collection and analysis, and there are many variables of interest rather than data points and multiple sources of data (Yin, 2009). Differently, in surveys, although phenomenon and context are again focused, the ability to investigate the context is very limited by, e.g., the number of respondents or number of variables (Yin, 2009). In a case study, the researcher collects multiple sources of data from a bounded system or systems (case-s), and explores a description to the case and case-based themes (Creswell, 2007). Although case study research is a qualitative approach, different from qualitative research which can only involve qualitative data, case study can involve qualitative, quantitative or both types of data (Eisenhardt, 1989). Besides, the necessity on the extent of researcher's control over behavioral events determines whether the method would be organized over an experiment, a case study or a historical method. Control or manipulation on behavioral events is only possible

in experiments, mostly carried out in a laboratory setting or in a social setting. On the other hand, histories are the dead past to which access or control is not possible. In case studies, contemporary events are examined, in which relevant behaviors cannot be manipulated or controlled, whereas history deals with non-contemporary events (Yin, 2009). A case study is applicable where a contemporary phenomenon is investigated in depth in a real life context, especially when the phenomenon and context cannot be distinguished clearly in real life situations; e.g. in experiments it is clearly distinguished (Yin, 2009).

In this study, it has been determined that case study would best fit the research problem, as an in-depth examination of risk factors in food supply chains is only possible in a real-life setting, by which multiple sources of data in different cases can be collected for exploring case-based themes.

4.2.1. Different Approaches in Multiple-Case Study Design

Case study draws from psychology, law, political science and medicine (Creswell, 2007). The aim in a case study is to establish meaning (Stake, 1995). Case study is not only the process of analysis, but also the product of analysis (Patton, 2002, Stake, 2005). Case study is the choice of what is required to be studied, rather than a methodological choice (Stake, 2005). As explained, case data is retrieved from interview data, observation, or any documentary evidence related to each case. Those records are organized, classified and edited into a format that could be used for further analysis (Patton, 2002). In order to ensure reliability and comparability, case study protocols were realized consistently across the cases (Ellram, 1996). In order to ensure construct validity, multiple data sources are used (Ellram, 1996), following a logical path from the development of a theoretical framework which provides the ground for question formulation, to the case study.

Case study may be intrinsic or instrumental (Stake, 2005). If the particular case being investigated is specifically the focus of the study for better understanding and probing, it is called intrinsic case study. If the particular case being investigated is of secondary interest, and plays more of a supportive role to provide an insight into one issue or redraw a generalization, it is called an instrumental case study (Stake,

2005). Intrinsic case work is usually identified a priori, whereas instrumental or collective case work needs to be selected (Stake, 2005).

Besides, case studies can either be designed as single or multiple (Stake, 2005; Yin, 2009). Single case design is preferred when the case under study is a critical test of existing theory, rare or unique circumstance, representative or typical case, or when the case serves for a revelatory or longitudinal purpose (Yin, 2009). In multiple case studies, there is more than one single case, jointly investigated in order to examine a phenomenon (Stake, 2005). Multiple case studies are also the extensions of instrumental case studies to several cases (Stake, 2005).

Although single cases are common design in the case study method, conducting multiple case studies are considered to be appropriate when sufficient time and resources are available (Yin, 2009). The evidence from multiple-case studies is more satisfactory, and would follow a replication. In multiple case studies, the number of case samples to be studied depends on the researcher, who is to ensure the sufficient number of case replications.

Case studies, single or multiple, can either be holistic or embedded, depending on the unit or subunits of analysis under study. In embedded design, attention is given to a subunit or subunits as the specific aspects of the case, whereas in holistic design, to the global nature of an entire case which might be an organization or a program. Holistic design is appropriate when there are no logical subunits available in a case, but this, on the other hand, prevents the researcher examining any specific phenomenon in operation detail. In an embedded multiple case design, the research is conducted at each case study unit, and the results will not be pooled across different case studies as in holistic design, rather the data will be part of each individual case (Yin, 2009). If case has different subunits, embedded design would be appropriate, which then could provide opportunities for other extensive research. Here, there is a risk of ignoring the holistic aspects of the study, and shifting of the focus towards subunits extensively (Yin, 2009).

Therefore, case studies can be designed in four types; single-case (holistic) designs, single-case (embedded) designs, multiple-case (holistic) designs and multiple-case (embedded) designs (Yin, 2009). If multiple cases are chosen, the detailed description of each case needs to be given first, and the analysis should first

be conducted in order to explore the themes within each individual case. Then, cross-case analysis, which is the thematic analysis across the cases, should be followed, interpreting the meaning of the case (Creswell, 2007).

4.2.2. Multiple-Case Study Design of this Research

Considering those, within the scope of this study, cases are defined as food supply chains. The empirical approach adopted in this study is qualitative, relying on observations, site visits, contextual information and semi-structured interviews with mid or high level managers within organizations at different levels of various food product chains, as well as with consumers. This study is considered as an instrumental (Stake, 2005) holistic multiple-case study, which is designed across five food supply chain types.

The multiple-case study was organized in a real life context (Yin, 2009); most of the interviewees were visited at their business sites. Within each of the cases, supply chain members from various levels were interviewed and observations were made, mostly at sites where the interviews took place. The particular cases were selected a priori to support the study to provide an insight into the issue under consideration. In order to ensure generalizability across an industry, the sample of the cases analyzed should need to be large enough for complete representation of that industry in general. Considering that the food industry is relatively complex and diverse in terms of both products and operations, in this study, a large sample was selected from five different food product supply chains, and from different levels of members.

4.2.3. Data Collection in Multiple-Case Study

In case study, there are three key principles of data collection, which also provides construct validity and reliability in case study evidence. The first one is the use of multiple sources of data (Yin, 2009). Second is to create a case study database in which all data, notes and records collected, are organized and documented systematically (Yin, 2009). The final principle is to maintain a chain of evidence and

make the process as explicit as possible (Yin, 2009). These principles are referred while collecting data in this multiple case study through semi-structured interviews and observations conducted from different food supply chain types. Those data are then combined with the literature notes to further shed light on the analysis.

The data is collected in food supply chains operating in Turkey. Turkey can be considered among the most attractive countries for global players, as it acts as a bridge between continents, both geographically and also in terms of culture, religion and economic policy (Demirbağ, Tatoglu and Glaister, 2009).

4.2.3.1. Semi-Structured Interviews

Qualitative researchers extensively prefer interview methods, which are guided conversations essentially conducted to collect rich evidence in case studies, especially on behavioral or human-related events (Yin, 2009). In cases where interviews are used as the fundamental and sole method of collecting data, the participant's perspective, ideas, feelings and views, thus only the subjective view is explored. If it is desired to extend the study towards a more objective view, it is necessary to collect data through other methods as well (Marshall and Rossman, 1995); combining data collection methods would reduce the effect of weaknesses caused by using a single method.

Four special types of interviewing are ethnographic interviewing, phenomenological interviewing, elite interviewing and focus group interviewing (Marshall and Rossman, 1995). Ethnographic interviewing is conducted in order to collect cultural data. Elite interviewing focuses on a particular or specific type of an interviewee, whereas focus group interviewing, which is mostly preferred in marketing research, focuses on groups of people. In contrast, in phenomenological interviewing, the aim is to explore experiences and worldview. Patton (2002) argues that there is a structure of shared experiences and views that can be explored and phenomenological interviewing focuses on identifying the bones of shared expertise on a special issue of a phenomenon (Marshall and Rossman, 1995).

In this study, the data is collected through multiple methods of direct participation, observation and interviewing, specifically by the phenomenological

interviewing, in order to describe the meaning of a concept or phenomenon for the participant in reference to their experiences, perspective, ideas, feelings and view (Creswell, 2007).

Interviews may be in in-depth, focused or survey format (Yin, 2009). In-depth interviews are conducted by key respondents who are basically critical to the success of the completed research. In-depth interviews may take place in a more extended period of time. In focused interviews, respondents are interviewed in a more limited time frame, e.g. an hour, and a certain set of open-ended questions are asked in a conversational format. Survey can be designed to produce quantitative data in an embedded case study (Yin, 2009). Another classification of interviews is informal conversational, general interview guide approach, or standardized open-ended (Patton, 2002). In-depth interviews are mainly conducted in informal conversational format. Here, the participant's focus is more important than the researcher's focus of interest and perspective. Personal interaction in interviews provides a large volume of data, but it relies highly on the skills of the researcher (Marshall and Rossman, 1995).

On the other hand, according to Stake (2005), group interviews have two main types; structured or unstructured. In structured interviews, same series of pre-established questions are asked to the respondents, offering limited categories of response. The responses are recorded according to a pre-established coding scheme, and little variation is left in responses (Stake, 2005). In contrast, unstructured interviews are informal, and allow a flexible environment for extending breadth of the negotiation (Stake, 2005). Open-ended questions are frequently asked, and thus such interviews provide flexibility in the research process.

Similarly, Matthews and Ross (2010) classify interviews further as standardized structured interviews, and non-standardized, which can also be in two forms: semi-structured or unstructured. In standardized structured interviews, there is a common set of questions asked exactly in the same way, with same words, which is presented to the respondent within a certain set of answers to be selected. In non-standardized unstructured interviews, the focus of discussion is broader, and the interview process is highly flexible to allow the respondent to talk freely on the research topic.

Semi-structured interviews are also non-standardized interviews, allowing the respondent to talk and discuss the research topic freely, and allowing the researcher to introduce topics or questions according to the needs of the interview process; but this time the researcher here follows a common set of topics or questions to guide the interview. Semi-structured interviews occupy a place in the middle of the continuum between structured and unstructured interviews. Semi-structured interviews are not as flexible as unstructured interviews, but still more flexible compared to structured, as the researcher can change the order and details of the topics under discussion (Bernard and Ryan, 2010). Semi-structured interviews are highly preferred by the researchers when both the experiences, beliefs, behaviors or perceptions of the respondents, and the information provided by the respondents are within the interest of the researcher. Therefore, it is not only the content of the conversation, but also the way each respondent expresses themselves that is the concern in semi-structured interviews (Matthews and Ross, 2010). That is also why, in semi-structured interviews, respondents are generally selected for their experiences and opinions, which help to explore the research topics in-depth (Matthews and Ross, 2010).

Recording, managing and analyzing the volumes of data in a qualitative research is another issue of concern. It needs to be systematically planned and carried out in order to record data by tape recorders, cameras or other devices, by considering the sensitivities related to confidentiality and to the participator's consent (Marshall and Rossman, 1995).

The data in this study is primarily collected through semi-structured interviews. In total, forty one people were interviewed face-to-face from five cases, where each case was a food supply chain of a product type. Ten of the forty respondents were ultimate consumers, and the other thirty one were mid-to-high level managers from different levels of food supply chains. Each respondent in each case was selected because their experiences, beliefs, behaviors, perceptions and opinions would help to explore the research topics in-depth. This data collection methodology through semi-structured interviews enabled a free discussion of the topic. By this, although the predetermined common set of topics or questions guided the interview, the topics or questions could be asked in a flexible way depending on the interview process. Prior to the interviews, each interviewee was promised

anonymity and their permission for recording was sought. Each session was recorded, and audio files were then transcribed into text files in order to provide a clearer and more systematic examination of the results. During the interviews, discovery-oriented approach (Yin, 2009) was used for probing the issue in details and for ensuring that the experience and knowledge of the professionals were fully reflected into the issue under consideration. In order to provide a natural interview atmosphere, the questions were asked in random order. After recording the interview data, every record was listened carefully in order to get a feeling for the context and the nuances in the interviews. Later, the interviews were transcribed into another form, digital text, which allows for systematic analysis (Bernard and Ryan, 2010).

4.2.3.2. Observation

Observation is a fundamental method in qualitative research. In observation, all events, behaviors or objects observed in the social setting of the study are systematically noted, recorded by the researcher, and accordingly complex interactions in natural setting or some patterns of behaviors and relationships can be discovered. Observation also plays a critical role in interview techniques (Marshall and Rossman, 1995). Observations let the researcher develop greater understanding on the cases (Stake, 1995), and allows for the collection of data through the act of watching and the use of human senses (Matthews and Ross, 2010).

The opportunity of a direct observation is possible in the natural setting, where case study is conducted and provides another source of evidence (even complementary) in case studies (Yin, 2009). Observations could range from formal to causal, e.g. meetings, side walk activities, factory work or visits...etc.

Validity in observation is very challenging and highly dependent on the experience of the researcher. It is important to keep and record notes in order to manage the vast amount of data collected while observing (Matthews and Ross, 2010).

In this study, thirty two companies were visited, and observations were made at twenty eight sites, generally at the places where the interviews took place.

Observations were either in formal or casual format; including side walk activities at the factories, at workplaces, warehouses, operations area or formal meetings.

4.2.4. Scope and Sampling of Multiple-Case Study

In multiple case designs, each sample must be selected very carefully, on one side to predict similar results for literal replication, or on the other side, to predict contrasting results for anticipatable reasons for theoretical replication. This replication logic should be distinguished from sampling logic, in which operational enumeration of the entire universe or pool of potential respondents is outlined and a statistical procedure for selecting respondents is followed (Yin, 2009).

In multiple case design, each individual case is considered as a whole study, and the conclusions from each case are then combined in an across case report, which should indicate the replication logic explaining why some certain cases have predicted certain results and some contradicting results (Yin, 2009). Case studies can contribute to theory building when properly designed and conducted. Eisenhardt (1989) states that for theory building through case studies, other than defining the research question and constructs a priori and selecting the cases through non-random theoretical sampling, it is also necessary to collect data through multiple methods, overlap data collection and analysis of field notes, analyze data first within cases, then make a cross case analysis would provide a base ground for shaping hypothesis. Additionally, following replication logic across cases can also help to confirm and extend theory. Especially, comparing the findings with similar, as well as conflicting literature sharpens generazability (Eisenhardt, 1989). Replication logic is an essential part of multiple case analyses (Yin, 2009).

Multiples case studies provide better results when the cases are not less than four, and not more than ten (Stake, 2006). This is because, cases of less than four do not show enough interactivity between situations, whereas cases of more than ten show the uniqueness of interactivity. One rationale behind conducting multi-case study is to examine the way different phenomena perform in different environments. Therefore, the selected cases should not be typical as well as atypical (Stake, 2006).

Sampling is very important in designing qualitative research (Coyne, 1997). In multiple-case designs, selection of the cases is critically important; these should be neither typical, for theoretical replication to predict contrasting results for anticipatable reason, nor atypical, to predict similar results for literal replication as well as (Stake, 2006; Yin, 2009).

In this study, samples are selected from food industry through purposeful sampling, from the companies and consumers located in Turkey. In each case, the food supply chain members, in which the most critical logistics operations are performed related to its product type and operations, are selected as the sampling units.

4.2.4.1. Food Supply Chains

The inherent nature of food supply chains differ from traditional supply chains in the sensitivity of its logistics processes. It is again a series of activities through which the products and services flow, from the initial process of the supply of raw materials, until reaching the final customers. However, throughout this flow, the quality of products is affected along with this journey, until the products reach the consumers (Rajurkar and Jain, 2011). This is basically due to the fact that food products are temperature and shelf-life constrained, and perishable in nature. Therefore, food supply chains are considered to be more complex and more difficult to manage, as it highly depends on the customer-driven factors, teamwork and knowledge, and again by the triggers that traditional supply chains face, such as globalization, increasing product variety, shortening product life cycles, growing number of supply chain partners and more demanding customers (Hsu and Wang, 2004; Rajurkar and Jain, 2011). This necessitated an increasing attention on the studies focusing on improving food supply chain efficiencies (Rajurkar and Jain, 2011). Supporting this view, Manzini and Accorsi (2013) suggest quality, safety, sustainability and efficiency as being primary key performance indicators (KPIs) for food supply chains. Achieving those critical objectives are major challenges in food chains, as this necessitates the exploration and integration of the problems and issues,

competencies as well as decisions within the sensitivity constraints of food chains (Manzini and Accorsi, 2013).

4.2.4.1.1. Logistics in Food Supply Chains

Key logistical aims of food supply chains are cost reduction, improved responsiveness, improved food quality, reduction of food waste, improved sustainability and improved traceability (Soysal et al., 2012). Legislations, increased customer's awareness, and pressures by non-profit organizations have forced companies to move towards an environmental and social focus in their logistic activities. This case is made more complicated by the intrinsic characteristics of food products and processes, requiring a different quality management, and surrounded by different types of enterprises which are involved in dynamic interactions (Soysal et al., 2012).

Smith (2008) identified four types of food supply chains namely local, conserved, manufactured and commodity-based. Each type has different characteristics, according to complexity of supply chains, transportation distance, and number of processing steps. In his definition, manufactured food product supply chains are considered among the most complex, with several processing steps and long transportation distances. These naturally bring additional risks to manufactured food product supply chains. On the other hand, food supply chains are identified based on the level of temperature to be maintained. These can either be temperature-sensitive, as frozen and chilled, or not, as ambient food supply chains (Akkerman, Farahani, and Grunow, 2010). As the temperature levels for frozen and chilled are important for maintaining food quality and safety, logistics activities for such food products therefore become a focus of critical attention (Akkerman, Farahani, and Grunow, 2010). Maintaining the climate control, especially in refrigerated products, inspection at borders, especially when unloaded, handling at different locations by different parties (e.g. by multimodality of transportation), transportation by air, rail or vessel, or the costs incurred by refrigerated trucks or refrigerated storage, are some of the challenges associated with cold chain logistics operations (Prentice and McLachlin, 2010).

4.2.4.1.2. Issues Related to Food Safety

In food supply chain management the key success is the integration of activities through the entire supply chain, and building complete transparency (Beulens et al., 2005; Rajurkar and Jain, 2011). However, food safety management on any scale is a challenging task, especially with multiple parties involved. Food chain covers all members, even the animal feed industry, from the initial stage to the ultimate consumers at the very end (Den Hartog, 2003), and this make it very challenging to manage the whole food supply chain from this comprehensive scope, and to develop an integrated framework on quality, safety, sustainability and logistics efficiency on food products, processes or food systems (Manzini and Accorsi, 2013).

In such a case of collaboration, the elements of trust, power, dependence, and risk-reward sharing in establishing and maintaining supply chain relationships become critically important (Matopoulos et al., 2007). Although supply chain collaboration is necessarily important for improving the efficiency and effectiveness management, it is a challenge in food supply chains to adopt a strategic collaboration, due to the structure of the food chain, as well as the nature of products (Matopoulos et al., 2007). There is a need to shift the focus of food supply chains towards non-quantifiable factors, which are mostly behavioral, such as trust, culture, power, relationship or power (Rajurkar and Jain, 2011). Therefore, 6T's, namely traceability, transparency, testability, time, trust and training, defined by Roth et al. (2008) are critically important for providing food safety, and preserving public welfare. 6T's, especially traceability, transparency and time, are negatively affected by the distance. This, coupled with cultural differences challenging the trust and training, and the inability of a thoroughly testability of food, makes management of 6T's remarkably difficult (Roth et al., 2008).

Besides, opportunism of supply chain parties for cost related concerns, such as reducing electricity consumption for energy saving, is an important factor threatening the safety of cold transport (Prentice and McLachlin, 2010). Moreover, price pressures might lead to opportunistic supplier behaviors, which could be much more costly in the long run (Roth et al., 2008).

In food chains, another important issue is the level of confidence and trust of consumers towards food chains and food products (De Jonge et al., 2004). Confidence in food safety relates to "the belief that the consumption of food products will not result in adverse health effects, as this is, under normal conditions, the expected outcome of consumption" and this is also the customer confidence which expects that "the food products will not cause any harm to their health or to the environment" (De Jonge et al., 2004:839). Customer concerns are increased as the transparency and traceability of food origins or ingredients become almost impossible with the growing complexity of food chains expanding over long distances transnationally (De Jonge et al., 2004). That also explains why risk management is critically important for food chains.

4.2.4.1.3. Risks Associated with Food Supply Chains

The generic model of food supply chain involves importing and exporting at all levels of supply chain members, who are mainly the farm suppliers, farmers, marketers or storage, processors, wholesalers or distributors, retailers and consumers. The risks associated with food chains are increasing due to challenges in control and safety issues with the increased levels of complexity in long globalized chains (Cavinato, 2004). The concerns are increasing on food safety and public welfare due to recent food supply chain trends of globalization, consolidation and commoditization, or the increasing import in foods and ingredients, lack of regulatory controls and other cultural aspects (Roth et al., 2008). These challenges in food chains, when not properly communicated or managed, also affect consumer's perceptions and lead to loss of trust and confidence on food chains in general (Houghton et al., 2006; Houghton et al., 2008; Von Kanel et al., 2010). Therefore, it is important to consider that consumers have a perception or an opinion on food issues, and expect food chain members to manage risks associated with their food-related activities (Houghton et al., 2006; Von Kanel et al., 2010), especially by developing a control system, identifying preventive measures and ensuring the availability of information at all levels (Houghton et al., 2006). The difference or similarities in the perceptions of stakeholders, especially the consumers and the

experts, has taken the attention of some researchers (Van Kleef et al., 2006; Krystallis et al., 2007). Although the experts perceive risks associated with food differently in some cases, they also share some common perceptions on the key issues related to food risk management; e.g. efforts of authorities in risk management, shared responsibility of preventing food risks, priority setting in food systems, scientific progress on food related tasks, attention of the media, and consumers' lack of awareness on food issues (Van Kleef et al., 2006; Krystallis et al., 2007).

Increasing number in food incidents has fostered a lack of consumer trust on food safety issues. It is clear that customers are aware of the effect of food risk management. Therefore, it is now critically important to outline the best practices expected by the consumers in food risk management, in order to re-gain their confidence (Van Kleef et al., 2009). It is nowadays evident that trust in the safety of foods has been undermined, and consumers have started to become increasingly involved in the focus of food risk management, rather than the process ending with retailers. Besides, there is an increase in public engagement with food issues. Consumer insights, especially on food safety perceptions, should be involved more in order to create value (Olsson and Skjöldebrand, 2008). Such changes have triggered a change in European Union (EU), in terms of developing new legislative and institutional frameworks (Houghton et al., 2008). Different stakeholders should participate in food risk management process. In particular, evaluating and communicating uncertainties is a major issue for enhancing appreciation of risks, as well as of food safety issues, and motivating different stakeholders to participate in the risk management process (Shepherd et al., 2006).

Within this scope, food risk can be defined as "a function of the probability of an adverse effect and the magnitude of that effect, consequential to a hazard(s) in food" (FAO/WHO, 1995:5). Risk assessment process involves the identification and characterization of hazards, and assessing the exposure and characterizing the risks. In risk assessment, the main aim is to estimate the risks of a hazardous event to negatively affect a population. In risk management, a structured approach is taken to protect human health, and policy alternatives are evaluated and implemented to provide a control. Risk communication is the share of information and opinions between related parties, including the consumers. In food risk management, public

health is the primary focus, and risks associated with food are regulated by the measures identified in order to ensure food safety and food security (FAO/WHO, 1995).

4.2.4.1.4. Sustainability Concerns in Food Supply Chains

On the other hand, the increasing trend in importing food products or ingredients, coupled with growing complexity of global sourcing, and inability of a comprehensive control provided by regulatory bodies pose a challenge to the quality preservation in food, which results in critical issues related to the public welfare (Roth et al., 2008). Food quality is related to the physical properties of food products, as well as to the perceptions of the consumers (Akkerman, Farahani, and Grunow, 2010). Food safety is related to the actions taken to prevent any illness caused by the consumption of a contaminated food (Akkerman, Farahani, and Grunow, 2010). Therefore, other than food safety and food quality, sustainability is now becoming a key concern for food supply chains as well (Akkerman, Farahani, and Grunow, 2010). Food quality and food safety are strongly interdependent on sustainability (Akkerman, Farahani, and Grunow, 2010).

Sustainability in food chains is becoming more and more important for regaining and retaining customer confidence and trust, which is increasingly being lost due to food incidents and scandals (Wognum et al., 2011). Sustainability within the scope of food chains refers to a very broad context, addressing all social, environmental and economic dimensions, such as the loss of biodiversity causal by modified genetic codes leading to epidemic hazards, degradation of agricultural land, increasing scarcity of water, and the use of antibiotic medicines in live-stock threatening human health. Moving management focus towards sustainability is pressured by both the consumers and other stakeholders (Wognum et al., 2011). Therefore, the United Kingdom (UK) Sustainable Development Commission defines sustainable food supply chains from a combined perspective of several stakeholders (Smith, 2008). In this definition, sustainable food supply chains aim to produce safe and healthy products to meet market demand. They need to ensure that nutritious food is available to all consumers, and accurate information is shared consistently.

Sustainable land management is at their focus and they operate with high sensitivity and awareness of natural resource limitations. Environmental performance is achieved through the activities which reduce energy consumption. Besides, renewable energy sources are used in sustainable food supply chains. Social performance is also an important factor for food supply chains, in which it is aimed to achieve a safe and hygienic working environment. Also training employees and improving social welfare is given high priority.

Therefore, in sustainable food supply chains, consumer value is created by providing more nutritious and healthier products, as well as through investing in sustainable procurement activities. Besides, adopting the business system into some standards and working with suppliers which meet such standards is also another important aspect of sustainability in food supply chains (Smith, 2008).

In food supply chain management, different stakeholders have different and conflicting interests. Integrating and balancing those diverging interests relating to different aspects, such as economic efficiency, environmental and social performance, food safety, marketing, is an important challenge (Fritz and Schiefer, 2008). Therefore, understanding and outlining the dynamics in critical success factors will help to improve competitiveness and contribute to sustainability as well (Fritz and Schiefer, 2008). Besides, it is important to improve transparency to foster sustainability, both at vertical and at horizontal levels of supply chains. From a sustainability framework, environmental reporting, traceability, labeling and life cycle assessment are four approaches for enhancing transparency in food chains. However, developing an integrated supply chain approach through adopting common strategies, or management systems and information systems is a vital requirement, but also, a critical challenge in terms of food chains and sustainability. Moreover, considering that social and environmental dimensions require a legal direction, the role of government is also necessarily critical (Wognum et al., 2011).

4.2.4.1.5. Approaching to Sustainability and Risk in Food Supply Chains

Food chains are not concerned for only quality or cost, but are also subject to public and media pressures in terms of environmental and social aspects (Pullman,

Maloni and Carter, 2009). Although the impacts are complex to explore and explain, sustainability practices have definite direct and indirect impacts on performance (Pullman, Maloni and Carter, 2009). However, it is generally difficult to identify the benefits caused by the sustainability programs. Energy plays an important role in food supply chains in terms of not only product quality or costs purposes, but also in terms of sustainability issues related to the degree of energy consumed, especially influenced by temperature and storage time (Zanoni and Zavanella, 2012). Climate change is an issue for also food supply chains, as food supply chains are affected by the variations in the temperature levels due to climate change, which consequently increases the risks associated with food spoilage and poisoning (James and James, 2010). Moreover, animal and human welfare is also of concern in sustainable food supply chains (Smith, 2008).

Despite this fact, risk management is not a regular strategy to be adopted in food chains. Rajurkar and Jain (2011) state in their review paper that studies focusing on food chain are in minority. Risk management is also suggested by Rodgers (2011) as an area of research to be studied in food chains, especially studies focusing on the design of risk management systems, or focusing on the behavioral aspects related to risk management. This part of the emphasis regarding the soft aspects, mostly related with psychology and sociology, are related with food supply chain and risk management, and are also proposed to be extended towards different actors, the workers, as well as to consumers, providing a direction for multidisciplinary view in relation to food chains and risk. Besides, this offered framework is necessarily suggested for a direction towards sustainability, which means a radical shift, not only in marketing concepts, but also in management.

4.2.4.2. Identification of Multiple Cases as Units of Analysis

In sampling decisions for research, unit of analysis is specified in order to decide on the sample size and sampling strategies (Patton, 2002). A unit is the individual respondent or subject from which the data will be collected, and unit of analysis of a research may either be at micro level (e.g. focus on the individual), or at macro level (e.g. focus on the organization, system or structure) (Matthews and Ross,

2010). Therefore, a unit of analysis may be people-focused (individuals, groups, families), structure-focused (projects, programs, units in organizations, organizations), worldview based (people who share a culture, common experience, perspective…), geography-focused, activity-focused, or time based (Patton, 2002).

Sampling is generally based on firms, individuals, functions, or groups as a unit of analysis, despite a need to design research which spans across supply chain partners, collects rich dyadic data, and takes supply chain as a unit of analysis, especially in sustainable supply chain studies (Carter and Easton, 2011).

Considering these factors, and the fact that the number of cases should not be less than four, but not be more than ten, food supply chains of five different product types were identified through purposeful sampling, as listed below:

- Meat Supply Chain
- Chicken Supply Chain
- Dairy Products Supply Chain
- Fish Supply Chain
- Retail Food Supply Chain

The supply chain types were determined from animal-product foods, due to special sensitivity of the products' characteristics towards sustainability and risks. The respondents were selected from each food supply chain type from Turkey, depending on the structure of each food supply chain.

4.2.4.2.1. Sampling of Multiple-Case Research in Food Supply Chains

The interviewees were selected with the goal of having a mix of leaders from different levels of five different food supply chains. Semi-structured interviews were conducted with leaders of all of the organizations, in order to provide a wide-ranging discussion and to reveal uniquely faced risks and sustainability practices (Eisenhardt, 1989).

In total, thirty two companies participated in the research. Forty-two supply chain members were selected to be interviewed, ten of who were the consumers (Table 2).

Table 2: Sample Size of Interviews and Observations

Supply Chain Members	Interviews		Observations
	$N_{(company)}$	$N_{(people)}$	$N_{(company)}$
Farm/Processing Plant	3	3	3
Manufacturer	5	8	5
Distribution Center	2	3	2
Road Transportation	3	4	3
Air Transportation	1	1	1
Vessel Transportation	1	1	-
Retailer	4	4	4
Dealer	1	1	1
Food Market	5	-	5
Restaurants	4	4	3
Consumers	-	10	-
Academician	1	1	-
Food Quality Laboratory/Audit	1	1	-
Food Safety Association	1	-	1
TOTAL	32	41	28

The companies selected to represent each type of food supply chain were both local market producers and exporters. Besides, the interviewees and the sites to be visited were identified based on the structure and complexity of each type of food supply chain. The respondents to be interviewed were selected among the leaders on the field, and on the company, with most not only experienced in their own product type in food industry, but also in various others. Although each has given more emphasis on their own expertise area, all respondents were asked to consider all logistics processes in the type of food supply chain in their discussions. Additional to interview questions, respondents were also asked to express their opinions, ideas, attitudes, perceptions, or to cite examples and support their statements.

4.2.4.2.2. Sampling in Interviews and Observations

Sampling could either be random probability sampling, or non-probability sampling, which is also referred as purposeful sampling. Random probability sampling is derived from statistical probability theory. The major rational behind random probability sampling is that it allows generalizability from a sample to a large population, and, as it is random, it controls for selection bias. In purposeful sampling, representative cases for study are selected to provide an insight about the phenomenon, and chosen to providing rich and valuable data regarding the subject (Patton, 2002). Probability samples are highly representative of the population, whereas non-probability sampling could not be used to generalize the findings to the population by statistical evidence. However, the discussion on generalization could be extended, depending on the extent to which the non-probability sample resembles the population (Patton, 2002; Matthews and Ross, 2010).

Purposeful sampling is used in qualitative research, in which the researcher selects the participants and sites which would best explain the research problem and phenomenon of the study. In purposeful sampling, the participants or sites to be sampled, their number and the form of sampling need to be decided by the researcher (Krippendorff, 2004; Creswell, 2007).

Purposeful sampling and theoretical sampling are used interchangeably in the literature. Patton (2002) states that all sampling in qualitative research is purposeful sampling, that is, the sample is selected purposefully to fit to the study. Therefore, one can consider theoretical sampling as purposeful sampling as well (Coyne, 1997). Theoretical sampling has origins in the grounded theory approach, and refers to the process of data collection in cases where the data collection, coding and analysis take place simultaneously. That is, next sample is determined based on the emerging codes and categories in the analysis of the previous data (Coyne, 1997). Different from purposeful sampling, the sample is varied according to the emerging theory in theoretical sampling (Coyne, 1997). Purposive sampling is associated in small, in-depth studies in which qualitative data is aimed to be explored, and perceptions as well as experiences are interpreted, such as case studies (Matthews and Ross, 2010).

Considering the above discussions, and the aim of the research, in this study, purposeful sampling methodology was used to identify the samples of interviews and observations from Turkey. First, the focal supply chain members from each food supply chain type were identified. Then among other relevant supply chain members, the parties to be considered within the interview scope were determined among the ones performing the most critical logistics activities in its related food supply chain. Care was taken to ensure that the sample had a sufficient number of consumers in order to incorporate their perceptions in the research data (Houghton et al., 2006; Van Kleef et al., 2006; Krystallis et al., 2007; Olsson and Skjöldebrand, 2008; Von Kanel et al., 2010;).

The decision on the sample size in qualitative research depends on the purpose or the depth of research, as well as their knowledge on the subject, time and resources. Whether the sample size is adequate or not, requires peer review and judgment. The researcher needs to discuss and explain the sample size rationale, and how it affected the findings (Patton, 2002). Therefore, the numbers of relevant supply chain members to be interviewed, and sites to be observed are determined accordingly. Besides, the extent to which sample represents the population of phenomena being analyzed, as well as represents the population other than that from which it is drawn (Krippendorff, 2004), was given consideration in order to ensure sampling validity. Therefore, the scope of research sampling as well as the sampling for the interviews and observations were determined accordingly.

This scope of the multiple-case study, showing the sampling units of interviews, as well as the observations for each case is presented in Table 3.

Table 3: Sampling Units of Interviews and Observations for each Food Supply Chain Type

Supply Chain Members	Food Supply Chain Types									
	Meat Supply Chain		Chicken Supply Chain		Dairy Products Supply Chain		Fish Supply Chain		Retail Food Supply Chain	
	Int.	Obsv.	Int.	Obsv.	Int.	Obsv.	Int.	Obsv.	Int.	Obsv.
Farm/Processing Plant	X	X			X	X	X	X		
Manufacturer	X	X	X	X	X	X	X	X		
Distribution Center	X	X			X	X	X			
Road Transportation	X	X	X	X	X	X	X	X	X	X
Air Transportation							X	X		
Vessel Transportation							X			
Retailer	X	X	X	X	X	X	X	X		
Dealer					X	X				
Food Market						X		X		X
Restaurants	X	X	X	X	X	X	X	X	X	X
Consumers	X		X		X		X		X	
Academician	X		X		X		X		X	
Food Quality Laboratory/Audit	X		X		X		X		X	
Food Safety Association		X		X		X		X		X

The sampling scope started from the supply chain level where the initial livestock process is performed, and ended up until the final consumer level.

4.2.4.2.3. Sampling Profiles of the Interviewees

The sampling profiles of the interviewees are shown for each Food Supply Chain in Tables 4-8.

As meat supply chain (Table 4) is more complex than others, one meat processing plant, one manufacturer and one distribution center was visited and observations as well as interviews were made at all visited sites (Table 6). The respondents were selected among the quality control (QC) leaders, who carry the risks throughout the complete supply chain logistics process. Although the meat manufacturer is a local-origin company distributing its products mainly to the local market, it also exports abroad. The local distribution is owned by the company itself. At meat processing facility, the QC manager was interviewed, who also is responsible for meat butcheries outsourced, as well as those owned by the company itself. At the manufacturer site, additional to the QC manager, logistics manager and

warehouse manager were also interviewed in order to cover the processes including local distribution. In distribution center, the logistics manager, who is a very experienced leader in the field, was interviewed. Therefore, the discussions during the interviews were extended through local market transportation and observations, as well as informal talks with workers and drivers were made at visited sites.

Table 4: Profile of the Respondents in Meat Supply Chain

Supply Chain Members	Meat Supply Chain		
	Int.	Obsv.	Position of the Respondent
Farm/Processing Plant	1	1	QC Manager
Manufacturer	3	1	QC Manager, Logistics Manager, WH Manager
Distribution Center	1	1	Logistics Manager
Road Transportation	1	1	General Manager
Retailer	4	4	Grocery Stores (2), Supermarket Chains (2)
Restaurants	2	1	Restaurant Managers
Consumers	10		
Academician	1		Department Of Culinary Arts and Management
Food Quality Laboratory	1		General Manager
Food Safety Association		1	FSA Meeting

The chicken supply chain (Table 5) is a more vertically integrated supply chain, including feed processing. Therefore, the interviews and observations were made at the manufacturer's site with the QC manager, who also provided information on the previous and latter processes as well.

Table 5: Profile of the Respondents in Chicken Supply Chain

Supply Chain Members	Chicken Supply Chain		
	Int.	Obsv.	Position of the Respondent
Manufacturer	1	1	QC Manager
Road Transportation	2	1	General Manager, Logistics Manager
Retailer	4	4	Grocery Stores (2), Supermarket Chains (2)
Restaurants	2	1	Restaurant Managers
Consumers	10		
Academician	1		Department Of Culinary Arts and Management
Food Quality Laboratory	1		General Manager
Food Safety Association		1	FSA Meeting

In the dairy products supply chain (Table 6), one of the biggest milk suppliers of the company was visited, and after a detailed tour of the milk farm and the facility, the plant manager of the farm was interviewed in order to understand the process starting from the feed stage until the milk is delivered to the manufacturer. Later, the manufacturer was also visited and observed, at which the QC manager and the manufacturing manager were interviewed. Then, the distribution center of dairy products manufacturer was also visited, and a detailed site tour was taken in the warehouse by the sales manager, who was later taken into the interview process as well. At the dairy products supply chain, one dealer was also visited and interviewed, in order to outline the problems related with the dealer side. Besides, one more observation was made at a dairy products food market.

Table 6: Profile of the Respondents in Dairy Products Supply Chain

Supply Chain Members	Dairy Products Supply Chain		
	Int.	Obsv.	Position of the Respondent
Farm/Processing Plant	1	1	Plant Manager
Manufacturer	2	1	QC Manager, Manufacturing Manager
Distribution Center	1	1	Sales Manager
Road Transportation	2	1	General Manager, Logistics Manager
Retailer	4	4	Grocery Stores (2), Supermarket Chains (2)
Dealer	1	1	Dealer Manager
Food Market		1	Food Market
Restaurants	2	1	Restaurant Managers
Consumers	10		
Academician	1		Department Of Culinary Arts and Management
Food Quality Laboratory	1		General Manager
Food Safety Association		1	FSA Meeting

Fish supply chain (Table 7) is another type of a food supply chain with specific sensitivities. Thus, first, a fish harvesting plant was visited, and the plant manager of the fish farm was interviewed. Then, two manufacturers were visited. Observations at visited sites combined with the interviews with QC and logistics, as well as the planning manager at the manufacturers, provided comprehensive information on the risks associated with the food product type. Moreover, one sales manager was interviewed in order to discuss the warehouse and distribution processes, and observations were made at two fish markets.

Table 7: Profile of the Respondents in Fish Supply Chain

Supply Chain Members	Fish Supply Chain		
	Int.	Obsv.	Position of the Respondent
Farm/Processing Plant	1	1	Plant Manager
Manufacturer	2	2	Logistics and Planning Manager, QC Expert
Distribution Center	1		Sales Manager
Road Transportation	1	1	General Manager
Air Transportation	1	1	Air Cargo Supervisor
Vessel Transportation	1		General Manager
Retailer	1	1	Supermarket Chain
Food Market		2	Fish Markets
Restaurants	2	1	Restaurant Managers
Consumers	10		
Academician	1		Department Of Culinary Arts and Management
Food Quality Laboratory	1		General Manager
Food Safety Association		1	FSA Meeting

On the other hand, the main operations on retail food chain (Table 8) take place at restaurants, as well as at the distribution process because the locally supplied or imported food materials either processed or raw, were intensively distributed to regional branches. Therefore, two managers, one of whom was food country manager, and other food branch manager, were interviewed. The observations were also made at the visited sites, which were the restaurants, as well as the food markets of the retail food chain. Besides, observation and detailed interview with the general manager of the logistics service provider of the retail food chain were made. The logistics service provider manages the supply chain of the retail food chain, which provided comprehensive information on the tasks discussed.

Table 8: Profile of the Respondents in Retail Food Supply Chain

Supply Chain Members	Retail Food Supply Chain		
	Int.	Obsv.	Position of the Respondent
Road Transportation	1	1	General Manager
Food Market		2	
Restaurants	2	2	Food Country Manager, Food Branch Manager
Consumers	10		
Academician	1		Department Of Culinary Arts and Management
Food Quality Laboratory	1		General Manager
Food Safety Association		1	FSA Meeting

Additionally, one logistics service provider which mostly distributes food products internationally, and one distributing locally were also visited and interviewed. Additional to the road transportation companies, interviews and observations were also conducted at air transportation and vessel transportation companies. On the retail side, two groceries, two supermarket chains were visited and interviewed. Besides, interviews were conducted with two restaurant managers, one of which was observed. One of the restaurants was served restaurant, and other provided catering services. This provided variety of information on the issues discussed.

Besides, the interviews with the general manager of food quality laboratory responsible for auditing the food supply chains on conformation to standards, and with one academician on the field, provided rich information on each individual type of food supply chain. On the other hand, one meeting of FSA was visited and discussions of food supply chain risks were noted.

As also being important members of food supply chains, ten consumers were also interviewed, and the risk factors, as well as sustainability related tasks in food supply chains, were discussed by each consumer for each individual type of food supply chain.

The road, air, vessel transportation companies, retailers, restaurants, food quality laboratory, academician and consumers were not only involved in the food supply chains of a single type, but to several others, including chicken, fish, milk…etc. Therefore, during the interviews with the related respondents, the questions were asked for each type of food product distinctively, and the risks as well as sustainability practices were identified for each type of food supply chain individually.

4.2.5. Analysis of Qualitative Data in Multiple-Case Study

The analysis of extensive volume of qualitative data is highly complex and challenging. At each stage of analysis, the data collected is sorted into manageable sets. The interpretation phase is the part where researcher translates the words and acts of the respondent into meaningful information. Of course, the interpretive phase,

both in qualitative and quantitative research, is highly personal; that is, highly dependent on the researcher. (Marshall and Rossman, 1995). The aim here is to generate categories, themes and patterns from voluminous data (Marshall and Rossman, 1995).

Analyzing the evidence provided by case study method is challenging. It is also the least developed aspects in case study methodology. The data collected in semi-structured interviews is unstructured, the responses are worded differently by the respondents, and the answers are varied also depending on the words or actions of the respondent.

The analysis part has different phases. Here, it is aimed to discover themes or categories or sub-themes, and describe their core elements. Besides, a hierarchical coding is again necessary to be attached to the actual text later, and to link them into a theoretical framework (Bernard and Ryan, 2010).

The qualitative data collected through the interviews are coded, and a codebook is formed showing and explaining the themes, as well as different categories in which the themes are grouped. The codes in the codebooks could be in three forms; structural codes, theme codes and memos (Bernard and Ryan, 2010). Structural codes represent the environment in which the interview is conducted, or the features of the respondent. Theme codes represent the interview text notes, and memos are the notes taken during the field observation (Bernard and Ryan, 2010). Having refined the codes, a hierarchical re-grouping is necessary. The number and content of the hierarchical levels change depending on the extent to which the themes become less fuzzy (Bernard and Ryan, 2010).

Different types of analysis can be used to interpret this kind of data, such as thematic analysis, discourse analysis, content analysis (Matthews and Ross, 2010).

Content analysis is the one which best serves to the aim of this study, as it is an approach for qualitative data reduction or effort to identify core consistencies and core meanings which constitute a pattern or theme from a volume of qualitative data (Patton, 2002). It is a method which follows a set of procedures to outline valid inferences about the senders or audience of the message and the message itself (Weber, 1990). Therefore, it can be defined as “any methodological measurement applied to text (or other symbolic materials) for social science purposes” (Shapiro

and Markoff, 1997:14). Therefore, content analysis would provide a roadmap for outlining and grouping risk factors in this study, and analyzing the findings from different perspectives of various members of the five of the food supply chains.

In general, content analysis may be text-driven, i.e. motivated by availability of rich texts, problem-driven, i.e. motivated by epistemic questions regarding some inaccessible phenomena, events or processes to be answered by available texts, or method-driven, i.e. motivated by the desire to apply analytical procedures to already explored areas (Krippendorff, 2004). Based on this framework, in this research, the content analysis employed can be defined as problem-driven, due to the fact that specific research questions motivate the interest of the researcher.

4.2.5.1. Content Analysis of the Multiple-Case Study Data

Although the intellectual roots of content analysis can be traced back in human history to the first use of symbols, voice and writing, it is primarily defined in Webster's Dictionary of the English Language in 1961, as "analysis of the manifest and latent content of a body of communicated material (as a book or film) through classification, tabulation, and evaluation of its key symbols and themes in order to ascertain its meaning and probable effect" (Krippendorff, 2004:xvii). Although the term *content analysis* was not used until 1941, systematic analysis of text, can be traced back to 17th century in inquisitorial pursuits by the Church, and the best well-documented qualitative analysis of print was undertaken in 18th century. The practice of content analysis is nowadays growing exponentially. One highly referred definition of content analysis is given by Krippendorff (2004:18) as "a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the contexts of their use".

Although content analysis is also defined as a research technique which provides objective, systematic and quantitative description of the content (Berelson, 1952), it is not necessarily quantitative in nature; qualitative analysis has been proven to be successful (Krippendorff, 2004). Therefore, content analysis is a data analysis technique mostly applied to text data. The aim in content analysis is to condense data into fewer and clear categories that could be better and easily understood. Although

initially it was used to find frequencies of certain words, more recently it has been used to look for the presence of words, understand their meanings and relationships, and to discover some patterns to help understand the underlying phenomena (Matthews and Ross, 2010). Therefore, content analysis is a set of methods which explores explicit and covert meanings in a text and allows for a systematic coding and analysis of the qualitative data. While creating a coding scheme, it is possible to code each word or different senses of words or the entire sentence, entire paragraph, entire text, or define a theme as a unit of text, and code it (Weber, 1990). While creating categories, it is important to decide whether the categories are to be mutually exclusive, that is, one recording unit can be classified simultaneously in more than one single category, and how narrow of broad the categories are (Weber, 1990).

In this study, content analysis was employed to analyze the data collected, as it offers an approach to reducing a comprehensive set of information into mutually exclusive categories. That is, large number of words in the text of the multiple-case study were classified into fewer content categories (Weber, 1990), and risk factors were classified into groups and re-groups at different hierarchical levels accordingly. Analyzing qualitative data through the use of content analysis (Tate et al., 2010) in the field of sustainable supply chain is also considered to be an innovative approach to develop rich understanding on the related issues (Carter and Easton, 2011).

4.2.5.2. Latent and Manifest Content Analysis

The analysis of qualitative data is challenging, and requires analytical rigor, creativity and intellectual discipline (Patton, 2002). In content analysis, coding can be recorded either manifest (explicit) or latent (implicit) (Kassarjian, 1977; Berg, 2001; Krippendorff, 2004; Babbie, 2010). Manifest content is the "the surface structure present in the message", while latent content is the ''deep structural meaning conveyed by the message" (Berg 2001:242). Latent coding procedure is concerned with the identification of the implicit meanings, patterns or symbolism of the dataset of a communication, and therefore is more valid (Babbie, 2010). In contrast, in manifest content analysis, researchers are more concerned with visible,

surface content of a communication which could be counted, and the main focus is mostly the word frequencies; that are to outline the most frequently occurring words (Weber, 1990). Manifest content analysis is followed when the elements are physically present and countable. The analysis is extended to latent content analysis when it is necessary to interpret the symbolism of the underlying data (Berg, 2001). One important advantage of manifest coding is that it is more reliable, as the content is more easily detected, identified, coded and counted.

Although latent content analysis seems to be better to outline the underlying and implicit meaning of communications, challenging issues to be considered are reliability and specificity (Babbie, 2010). This is mostly because, manifest content can be assessed by software tools, whereas latent content is the case when categorizes are identified relying heavily on interpretations by looking at the deeper and soft or meanings in the texts. One important advantage of computer-aided content analysis is that the rules and procedures for coding text can be made explicit. Besides, computer-aided programs provide perfect reliability in applying coding rules to text (Weber, 1990).

Computers play role in not only quantitative analysis, but also in qualitative analysis. Computer-assisted qualitative data analysis software helps researcher to code and categorize large volume of text data collected through open-ended interviews or other written materials such as articles, newspapers…etc. (Yin, 2009). Computers and software are the tools that do not analyze data themselves, but they actually help to analyze data (Patton, 2002; Yin, 2009). People design the study, collect and analyze data with the help of computers and software. The analysis by computers and software facilitate the storage, coding, retrieval, comparison and linking of data, as well as grouping, indexing, or categorizing data, in both quick and accurate manner. Some examples of software used in qualitative data analysis are winMAX, TextSmart, AnSWR or QSR NVivo. Computer software programs facilitate the analysis of qualitative data by storing and organizing data as well as coding and forming themes from voluminous data. By the use of computer software programs, common messages can be outlined and segmented. It allows for a comparison among different codes, and helps researchers to conceptualize them. The

codes, then, could be organized hierarchically and upper code levels could be formulated in themes (Creswell, 2007).

Here, in this research, dimensions and related categories to be used for classifying the reviewed material was derived inductively, which means categories were derived from the material under examination itself, not extracted from the existing theory, and assessed before the material was analyzed as in a deductive approach (Eisenhardt, 1989). An iterative process was followed in building, testing and revising categories based on constant comparisons of categories with data.

Besides, in this research, since the interviews were conducted with several managers from different levels of five food supply chains, it was obvious that different words might have been used to convey the same meaning, or in contrast, similar words might have been used to convey different meanings. Therefore, first the latent meanings of the words were interpreted in content analysis in order to outline the associated risk factors. Those latent coding of the risk factors were then verified through manifest content analysis. In order to outline if the risk factor codes defined in the latent content analysis of the multiple-case study do exist in the literature and in which frequency, an article search was conducted in *web of knowledge* database. Web of knowledge was selected as the reference database as it is one of the most credible databases in academy. The articles which contain *risk* in title and *supply chain* or *logistics* in topic were downloaded. Among many, the language was limited to English, and the document type was restricted to article only. As a result, 488 articles could be accessed. The risk factor codes defined in the case study were searched in these 488 articles through the use of NVivo software. NVivo is the latest version of QSR international which helps to manage, analyze and shape qualitative data while enabling the researcher to manipulate data easily and conduct the research (Creswell, 2007). Thus, each risk factor code was verified by referring to these results, as well as to the results of the scan of the literature in *Google Scholar*.

4.2.5.3. Within and Cross Case Analysis of Multiple-Case Study

People are generally poor processors of information, especially resulting from biases in the information-processes. This, coupled with enormous volume of data collected, might result in researchers' poor and immature conclusion on the tasks. In order to overcome this problem, analyzing and comparing the cases in several divergent ways would become necessarily important in case studies. Analyzing data by a structured format, and using diverse lenses on the data would help researchers to go beyond initial ideas or impression which would lead to biases. This might be done in several ways; such as, first looking for within-group similarities for a specified dimension or category, and then looking at intergroup differences; or looking at similarities and differences between each pair once selecting the pairs of cases; alternatively data might be divided by data source and the analysis would be made further (Eisenhardt, 1989).

Data analysis is at the heart of research. In order to cope with voluminous data, one key step is to conduct within case analysis, which means probing and analyzing each case as a standalone entity (Eisenhardt, 1989). In this way, researchers can become highly familiar with each case, and therefore can explore unique patterns of each case. This provides a base ground to generalize patterns across cases, thus, accelerating cross-case comparison (Eisenhardt, 1989). On the other hand, cross case analysis shows what is common or different across cases, rather than what is unique to each (Stake, 2006).

Therefore, in this study, by within case analysis, risk factors were evaluated for each food supply chain type in order to be familiar with each case and explore unique patterns of each case. Besides, cross case analysis was made to identify patterns across different food supply chain types, and the case by case format was rearranged into a construct by construct format.

4.2.6. Quality of Multiple-Case Research

Qualitative research is objective (Kirk and Miller, 1986). The two major components of objectivity are reliability and validity. Reliability refers to "the extent

to which a measurement procedure yields the same answer however and whenever it is carried out" and validity refers to "the extent to which it gives the correct answer" (Kirk and Miller, 1986:19). In social sciences, reliability can be assured by different techniques, while perfect validity is almost impossible to attain. Thus, most of the studies in qualitative research address reliability, but do not refer to validity (Kirk and Miller, 1986). On the other hand, Lincoln and Guba (1985) present four main constructs that would be appropriate for a qualitative inquiry; credibility, transferability, generalizability and confirmability. A qualitative inquiry needs to be credible; that is, the subject is accurately identified and described, reflecting the original realities in consideration. Besides, it needs to be transferable and generalizable; that is, the findings would be applicable to other settings, and generalized to the larger population from which the sample was drawn. This transferability and generalizability of the qualitative research is the problematic part, and needs to be tied to or supported by a theoretical body (Marshall and Rossman, 1995). The last construct is confirmability, which means the findings of the study can be confirmed by another, in order to remove the objectivity of the researcher (Marshall and Rossman, 1995). In order to ensure reliability and comparability, case study protocols were realized consistently across the cases (Ellram, 1996).

In general, the quality of research design is judged based on four criterion; construct validity, internal validity, external validity and reliability (Yin, 2009).

Construct validity is related to the extent to which correct operational measures are identified for the concept under study and is one of the first and also the most challenging tests on judging the quality of case studies. In case studies, the subjective judgments of the respondents are collected, therefore it might be challenging to develop a sufficient level of operational measures. Second is the internal validity, by which, the research aims to establish causal relationships. Although this is given greatest attention in experimental and quasi-experimental research and mostly refers to explanatory case studies, tactics such as pattern matching, explanation building, addressing rival explanations and using logic models are used to ensure internal validity in case studies. Third is the external validity, which refers to the extent to which the findings of the research can be generalized towards others. This is considered to be another barrier in conducting case studies, as

case studies rely on analytic generalizations, rather than statistical generalizations as e.g. in surveys. Therefore, the use of theory in single case studies, replicating the findings in other case studies, and ensuring that same results are outlined in multiple-case studies is necessary to ensure external validity. Last is reliability, also called replicability or dependability, which refers to the extent to which the same results are repeated by the operations of a study, and error and bias in the study is minimized.

Validation in qualitative research is necessarily provided by documenting the accuracy of the study. During this research process, building trust with the participants was given priority, and any potential misinformation that might arise from any distortions in conversation was checked. Besides, multiple methods towards crystallization were used to validate the findings (Richardson, 2000; Tracy, 2010). The details regarding the process and the findings were all written in rich and thick descriptions to ensure transferability of the information to different settings (Marshall and Rossman, 1995). Biases do exist at the researcher side, depending on past experiences or individual interpretations on the issues discussed within the context of the cases. Therefore, the research design in general, methods, interpretations, transcribed notes as well as the analysis results were taken into peer review sessions by an academician in the field periodically, to provide an external check on the research process (Creswell, 2007). Besides, two of the informants reviewed the case reports to ensure that the interpretations and findings were accurately demonstrated as, a check on the validity of the research (Yin, 2009).

In order to overcome the challenge related to construct validity, in this study, multiple sources of evidence were explored in multiple-case study, a chain of evidence was established, and the case report is discussed by two key respondents. Moreover, great attention was given to the sampling design and analysis in order to ensure construct validity (Yin, 2009). The purposeful sampling approach provided a sample from a mixture of firm from different stages of supply chains, at multiple sites. The matching of respondents and companies across the dyads represented a form of crystallization. Furthermore, patterns were identified, explanations were built and rival explanations were addressed in within and cross case analysis to ensure internal validity. Moreover, the external validity was discussed in within case analysis, in which replication of the findings in different case studies were presented.

Besides, cross case analysis was used to determine whether the same results were outlined in multiple-case studies (Yin, 2009).

In order to ensure the reliability in qualitative research, a good-quality recording is critically important to outline a clear transcript on the tape. In this research, all interviews were recorded in good-quality, and transcribed into text format without any omissions. Therefore, case study protocol was used to document the procedures followed, and the complete operational process and case study database was formed (Yin, 2009). Later, an inter-coder agreement check was conducted, and multiple coders analyzed the transcript data to check whether the codes and themes were coded the same way as in the analysis (Creswell, 2007).

4.2.7. Reliability and Validity in Content Analysis

Content analysis is a technique and a scientific tool, which involves specific procedures; thus should provide reliability through the replicability of its findings, as well as validity (Krippendorff, 2004). Consistency and reliability of the content classification is an important issue in content analysis. Especially, the ambiguity related to the meanings of the words, category and coding procedures can lead to problems in reliability and validity. Validity of the research relates to the extent to which the variable of the content analysis measures the construct which the researcher intends to measure (Weber, 1990).

Reliability of a content analysis depends on its extent of stability, reproductability and accuracy (Krippendorff, 2004). Stability, as being the weakest type of reliability is achieved when there is consistency in coding; that is, when the same content is coded more than once by the same coder and the results of the content classification is invariant over time. Reproductability, which is also referred as inter-coder reliability, is achieved when more than one coder codes the same text and outlines same results from the content classification. In inter-coder reliability, other researchers independently examine the text and the data, and draw comparable solutions (Berg, 2001). High reproductivity is a minimum standard for content analysis as the consistency in the individual coder's understanding is measured by stability; whereas the consistency of two or more coders' shared understandings are

measured by reproductivity (Weber, 1990). In content analysis, there are different methods for reporting reliability. Cohen's kappa is commonly recommended for measuring ex post agreement between decoupled coders (Dewey, 1983). For ensuring reliability, coefficients would be greater than 0.60, indicating that above moderate to high levels of agreement is achieved. If the coefficient is less than 0.60, this indicates that moderate or less agreement is achieved, and the discrepancies of interpretations of constructs between different coders have to be aligned, and data has to be re-coded (Landis and Koch, 1977). Another way of reporting reliability is "discursive alignment of interpretation" (Seuring and Gold, 2012:547), in which no constant decoupled coding required; instead additional insight is used to discuss debatable issues. In this method, in cases where different judgments occur, they are assessed individually and resolved by discussing the causes leading to discrepancies. Therefore, coders discuss and debate the issues in which discrepancies occur. This method is highly preferred in SCM researches which require qualitative data analyses, especially when categories are characterized as latent contents (Seuring and Müller, 2008; Seuring and Gold, 2012; Haavisto and Kovacs, 2014; Hahn and Gold, 2014; Sartor et al., 2014). On the other hand, accuracy, as being the strongest form of reliability, is achieved when the classification of text depends on a standard or a norm. One major issue related to reliability is that, reliability of the coding is almost never assessed; or even when assessed, the disagreements between coders are resolved through negotiations, which might lead to biases towards dominant opinions. Therefore, it is important to calculate the reliability of coding before solving the disagreements (Weber, 1990; Krippendorff, 2004).

Validity of content analysis would be measured by internal (face) validity or external validity. Face validity, also referred as internal validity, shows the extent to which the researcher's definitions of concepts and their measured categories in fact correspond. Although content analysis is highly reliant on face validity, it is still considered to be a weak claim in terms of proving the validity (Weber, 1990). On the other hand, a stronger proof of validity depends on external validity, which can be in four types: construct validity, hypothesis validity, predictive validity and semantic validity (Weber, 1990). Construct validity refers whether the construct can be generalized across methods or measures. It is the extent of a measure to be correlated

with other measures of the same construct. High construct validity is achieved once one measure correlates with other measures of the same construct, which is also referred as convergent validity, or once one measure in uncorrelated with measures of dissimilar constructs, which is also referred as discriminant validity (Weber, 1990). Moreover, hypothesis validity relates to the extent to which one measure behaves as expected when in relationship to others, predictive validity refers the extent to which any of the forecasts external to the study correspond to actual events, semantic validity refers to the classification of coding as required to have been possessing similar connotations. Considering the ambiguity of words and category definitions, although obviously required, validity in content analysis cannot be proven easily (Weber, 1990).

Of course, having defined the categories, it is also necessary to test the clarity of category definitions in a small sample of text, and then apply it to the entire text. Especially in computer programs, the accuracy and reliability of the coding process needs to be assessed as well, and coding rules should be revised in case of low reliability, until sufficient levels of reliability are achieved. The reliability of human coders needs to be assessed after the classification of the complete text is finalized (Weber, 1990).

The reliability and validity of the research in this study is reported in Table 9. In this study, in order to assess validity, reduce interpretive bias, and increase the reliability of findings, the coding and interpretation process was checked by three academicians from the field, and the extent to which they arrived at the same findings was reported (Berg, 2001). Reproductivity, which refers to the extent to which two or more coders' shared understandings (Weber, 1990), was reported through "discursive alignment of interpretation" (Seuring and Gold, 2012:547) which is a commonly used method in latent content analysis in supply chain management research (Seuring and Muller, 2008; Seuring and Gold, 2012; Haavisto and Kovacs, 2014; Hahn and Gold, 2014; Sartor et al., 2014). Therefore, when discrepancies occurred in the coding, coders discuss the causes and provide additional insight. The reliability of coding was reported before the disagreements between coders were solved in order to avoid any biases towards certain opinions (Weber, 1990; Krippendorff, 2004).

The inter-rater reliability was reported as being quite high (95%) by the three scholars selected from the field. Some different judgments were individually assessed and resolved, while some discrepancies were aligned through "discursive alignment of interpretation" (Seuring and Gold, 2012:547).

Table 9: Reliability and Validity of the Research

Test	Definition	Tactic	Implementation in Case Study and Content Analysis
Internal Validity	The extent to which conclusions can be drawn for causal effects and causal relationship can be established	• Pattern Matching • Rival Explanations • Logic Models • Explanation Building	• Multiple food supply chain types are selected • Within case analysis is performed • Cases included semi-structured interviews and observations • Patterns across different cases are investigated and identified • Different relationships are examined among different levels of supply chain members • Discussed and documented interviews
Construct Validity	The extent to which the research instruments measure what they are supposed to measure; Establishes the correct operational measures for the constructs being studied	• Establish a chain of evidence • Use multiple sources of evidence • Key informants review draft of report	• Multiple sources of evidence are explored in multiple-case studies, a chain of evidence is established and the case report is discussed by three key respondents (discursive alignment of interpretation) • Used informants with different perspectives and conflicting interests which are also from different organizational levels belonging different food product chain types • Two key informants reviewed the case report • Multiple documents are collected and reviewed • A great attention is given on the sampling design and analysis
External Validity	Extent to which the research results can be applied to the population and the settings of interest; Then establishes a domain in which the findings of the study can be generalized	• Use replication logic in multiple case studies • Use case study protocol • Develop case study database	• Multiple case study is conducted among five different food product supply chains • Used and followed a case study protocol throughout the case study • Created a case study database
Reliability	Extent to which the findings demonstrate repeatability		• All interviews are recorded in good-quality and transcribed into text format with all details • Case study protocol is used to document the procedures followed and the complete operational process and case study database is formed • An inter-coder agreement check is conducted and multiple coders analyzed transcript data to check whether the codes and themes are coded the same way as in the analysis • The coding and interpretation process is checked by three academicians on the field and the extent to which they have arrived at the same findings is reported • Reproductivity is reported through discursive alignment of interpretation

Source: Created by the Author (adopted from Yin, 2009)

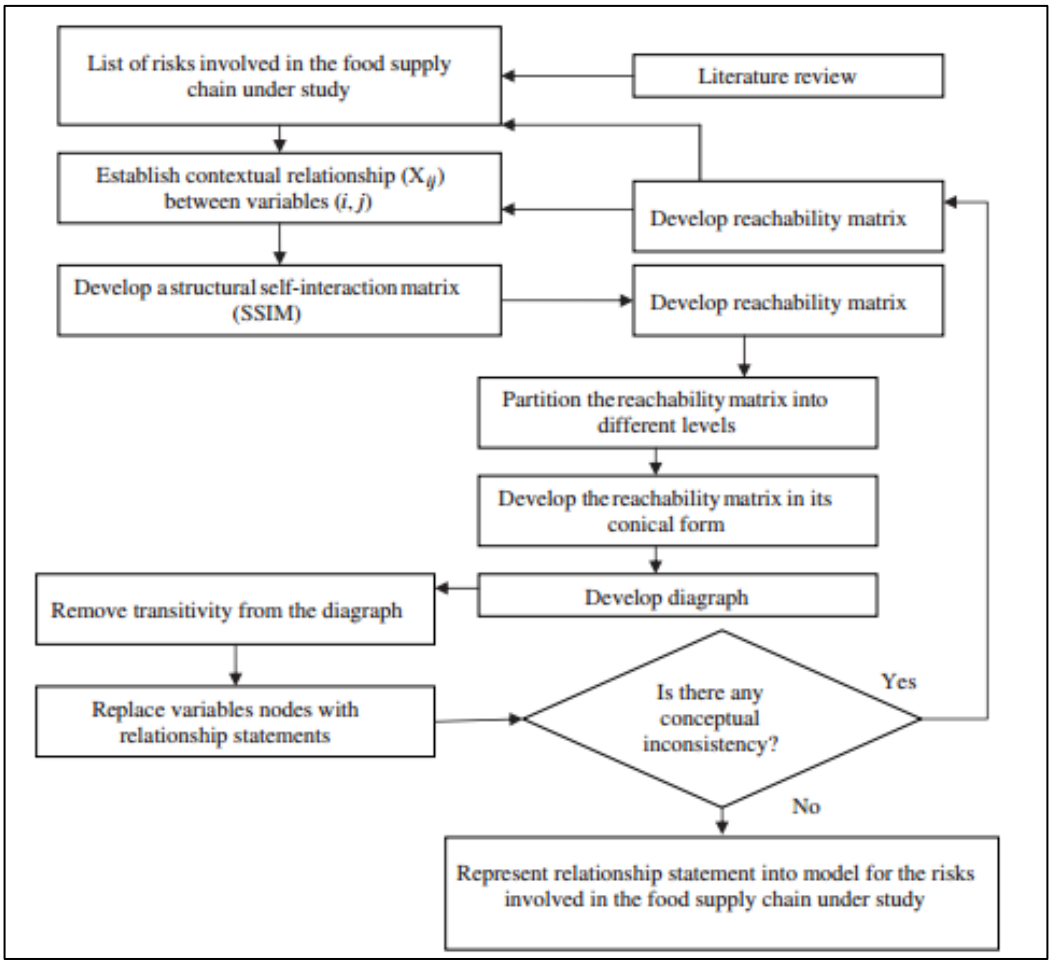
4.3. MODELLING THE CONCEPTUAL FRAMEWORK OF THE STUDY

Complex situations with large number of elements interacting at different dimensions cannot be easily modeled into a clear structure. Therefore, methods providing a path for rational decision making are necessary. ISM is a modeling technique, a methodology, applied in such complex situations to transform an unclear, poor and unstructured model into a structured, well-defined system, especially in cases where the variables are subjective.

ISM, Analytic Network Process (ANP) and Analytic Hierarchy Process (AHP) are the three contemporary techniques for modeling multi-criteria decision making. In AHP, there is a hierarchy which has to be followed strictly, whereas ANP copes with looser networks. Different from the two others, in ISM, a set of interconnected criteria are directly or indirectly related, and are transformed into a comprehensive structured model. Although AHP fails in dealing with complex problems, ANP is considered to be useful in non-linear problems, whereas ISM deals more effectively with the complexities of problems (Shahabadkar, 2012). Therefore, based on the degree of inheritance of different variables and the number of interactions, AHP, ANP, ISM can be chosen as a methodology for analyzing problems (Alawamleh and Popplewell, 2011). ISM helps to outline the direct or indirect relationships of different items, and structures them within a framework of a conceptual model. Through ISM, a comprehensive understanding and visualization of complex relationships can be outlined in a structured and clear manner (Attri, Dev and Sharma, 2013). Although ISM is applied in group learning process, it is also applied by the individuals (Faisal, Banwet and Shankar, 2007; Alawamleh and Popplewell, 2011; Shahabadkar, 2012).

ISM process is outlined in Figure 9:

Figure 9: Flow Chart of ISM Methodology



Source: Diabat et al., 2012

The history of ISM lies upon mathematical ground (Harary, Norman and Cartwright, 1965), but the fundamental philosophical ground is first proposed by Warfield (1973). The first step in ISM is the identification of variables related to the issue or problem under consideration. Then comes the part in which the contextual relationships are defined. This helps to formulate the structural self-interaction matrix (SSIM), based on the pairwise comparison of variables, which is then converted into a reachability matrix.

In developing SSIM, the contextual relationships between the variables are coined based on the expert or academic opinions, depending on the problem probed. The conceptual relationships might either be tagged as 'aggravates', 'enhances', 'precedes', 'contributes to'…etc. (Bolanos et al., 2005). Then, the associated directions of relationships between the two factors (*i* and *j*) are identified through the notations 'V', 'A', 'X' and 'O'; V for relation direction from *i* to *j* (i.e. if *i* will influence *j*), A for relation direction from *j* to *i* (i.e. if *i* will be influenced by *j*), X for both relation directions (i.e. *i* and *j* will influence each other), O for no relation (i.e. *i* and *j* are unrelated).

The conceptual relationships are converted into an initial reachability matrix with the binary numbers assigned to each type of relationship, based on the rules for this substitution; in cases where (*i*,*j*) entry in SSIM is V, (*i*,*j*) entry is assigned 1 whereas (*j*,*i*) is assigned 0; in cases where (*i*,*j*) entry in SSIM is A, (*i*,*j*) entry is assigned 0 whereas (*j*,*i*) is assigned 1; in cases where (*i*,*j*) entry in SSIM is X, (*i*,*j*) entry is assigned 1 whereas (*j*,*i*) is assigned 1; in cases where (*i*,*j*) entry in SSIM is O, (*i*,*j*) entry is assigned 0 whereas (*j*,*i*) is assigned 0 (Diabat, Govindan and Panicker, 2012). At this stage, the transitivity rule is adopted into the relationships. The transitivity rule suggests the assignment of a relationship in cases of indirect relationships. That is, if 'A' is related to 'B', and 'B' is related to 'C', then 'A' is related to 'C2. Therefore, all relationships with a binary assigned '0', and supporting this rule are converted into '1'. This final matrix is the final reachability matrix by which all final analysis will be made.

Based on the final reachability matrix, the reachability set, which involves the factor itself and the other factors it has on impact, and the antecedent set, which involves the factor itself and other factor that it has an impact on, are compared, and the intersecting factors between those two sets are outlined. The factors in which the reachability set and intersecting set are the same formulate the top-level factors, the level having no influence on other factors above their own level in the hierarchy. Those iterations are repeated until all factors are assigned to a level in the hierarchy. Those elements, their relationships, and the relative interdependencies can be visualized through a final digraph. The final model is the ISM, which can be structured and figured based on the above digraph. The conceptual inconsistency is

checked at the latest step to ensure the resulting discussions provide relevant insights on the problem.

The concluding relationships can also be calculated through MICMAC analysis. MICMAC is *Matrice d'Impacts Croises Multiplication Appliquee a un Classement*, or 'Cross-Impact Matrix Multiplication Applied to Classification', which is first developed by Duperrin and Godet (1973). It helps to analyze the driver versus dependence power of the variables, and outlines the key variables driving the complete system. Four categories are identified based on the variables relevant dependence and driver powers; 'autonomous factors' with low drive and dependence powers relatively disconnected from the system, 'linkage factors' with high drive and dependence powers interactively impacting the system , 'dependent factors' with low drive and high dependence powers, and 'independent factors', with high drive and low dependence powers. Key factors are the ones with very strong driver power, involved in independent or linkage factors (Attri, Dev and Sharma, 2013).

ISM provides a systematic approach to modeling complex sets of variables and different direction of relationships. The structured model and the graphical presentation of the interdependencies provide an efficient review of the comprehensive problem under consideration. However, all variables, whether having a big or only a minor impact, are taken into consideration in ISM model. Besides, the assignment of relationships involves bias, and strongly depends on the knowledge and experience of the experts. Despite those drawbacks, it is highly adopted by the researchers at different fields, including supply chain management (Bolanos et al., 2005; Faisal, 2010b; Alawamleh and Popplewell, 2011; Shahabadkar, 2012; Attri, Dev and Sharma, 2013) to use its power in obtaining structured and ordered conclusions of complex issues. It also is adopted in studies of risk management in supply chains (Banwet and Shankar, 2006; Alawamleh and Popplewell, 2011; Faisal, Diabat et al., 2013), as well as in food industry (Sagheer, Yadav and Deshmukh, 2009; Diabat et al., 2013).

In this study, the risk factors, which were identified by multiple-case study in food supply chains, were visualized by implementing ISM methodology. This approach also outlined the root cause among several risk factors.

4.4. PRIORITIZATION IN FUZZY AHP

Analytic solution to MCDM problems can be employed when all parameters are well-defined in a quantitative manner. However, in cases where evaluation criteria are subjective and qualitative, expressing preferences through exact numbers is very difficult, which makes decision-making very challenging (Chan and Kumar, 2007; Wang et al., 2012). Analytical hierarchy process (AHP) is a widely employed methodology to facilitate MCDM problems with qualitative assessment parameters by setting up a hierarchy of criteria and sub-criteria, through the introduction of pair-wise comparison between those criteria by professionals or experts in the area. This helps to convert expressions into numeric forms of values, which enables a base for comparison. The pioneer of AHP was Thomas L. Saaty who first introduced this extensively used methodology in 1980 to provide a direction for decision making in complex scenarios.

4.4.1. Steps for Applying Analytical Hierarchy Process

In AHP, the unstructured problem is first defined, and the objectives as well as the outcomes are set. This complex problem is decomposed into a hierarchical structure with decision elements (Kahraman, Cebeci and Ulukan, 2003; Haq and Kannan, 2006; Çakır, Tozan and Vayvay, 2009; Yücenur, Vayvay and Demirel, 2011). The hierarchical structure of the MCDM problem is presented by defining the overall goal, alternatives associated with the goal, as well as the criteria that relate the alternatives to the goal. The objective or overall goal of the decision is represented at the top level of the hierarchy. The criteria to evaluate the alternative are represented at the intermediate level, whereas decision alternatives are at the last level of the hierarchy. There is no one single procedure to draw the hierarchy; rather it is constructed depending on one person's perspectives, the nature or type of the managerial decision or the complexity of the problem (Zahedi, 1986; Saaty, 2005).

Next, pairwise comparisons are then employed among those decision elements to form comparison matrices and establish the priorities. The pairwise comparisons are carried out through the one-to-nine ratio scale of Saaty (1980) for

given *criterion i* and *criterion j*. The relative importance scale offered by Saaty is a standard preference scale which attributes values from 1 to 9 when comparing two alternatives and the weights, calculated accordingly, help to position each element inside the defined hierarchy (Saaty, 1980; Saaty, 2005; Haq and Kannan, 2006; Yücenur, Vayvay and Demirel, 2011). Each scale measurement has a different meaning as explained in Table 10.

Table 10: Scale of Relative Importance

Intensity of Importance	Value Description	Explanation
1	*Criterion i* and *criterion j* are of equal importance.	Two activities contribute equally to the objective.
3	*Criterion i* is weakly more important than *criterion j*.	Experience and judgement slightly favour one activity over another.
5	*Criterion i* is strongly more important than *criterion j*.	Experience and judgement strongly favour one activity over another.
7	*Criterion i* is very strongly more important than *criterion j*.	An activity is strongly favoured and its dominance demonstrated in practice.
9	*Criterion i* is absolutely more important than *criterion j*.	The evidence favouring one activity over another is of the highest possible order of affirmation.
2, 4, 6, 8	Intermediate values between the two adjacent values	When a compromise in judgement is needed.
Reciprocals of above	If *criterion i* has one of the above non-zero numbers assigned to it when compared with *criterion j*, then *criterion j* has the reciprocal value when compared with *criterion i*.	

Source: Saaty, 1980

Having identified the pairwise comparisons for all criteria, $n\,x\,n$ positive reciprocal matrix A is generated for $C_1, C_2, \ldots, C_n,\ n \geq 2$ criteria, in which the elements α_{ij} indicates the value of criterion i relative to criterion j, where $\alpha_{ii} = 1$. In cases where, $\alpha_{ij} = k$, the reciprocity property is represented as $\alpha_{ji} = 1/k$.

	$\mathbf{C_1}$	…	$\mathbf{C_j}$	…	$\mathbf{C_n}$
$\mathbf{C_1}$	α_{11}	α_{12}	α_{1j}		α_{1n}
⋮	⋮	⋮	⋮	⋮	⋮
⋮	⋮	α_{ii}	α_{ij}	α_{ik}	
$\mathbf{C_j}$	α_{j1}	α_{ji}	α_{jj}	α_{jk}	α_{jn}
⋮	⋮	⋮	⋮	⋮	⋮
$\mathbf{C_n}$	α_{n1}	…	α_{nj}	…	α_{nn}

The relative weights of the decision elements are estimated through eigenvalue method. Here, it is necessary to check the consistency of matrices in order to ensure that the judgments of different decision-makers are consistent. Finally, an overall rating for the alternatives is obtained by aggregating the relative weights of the decision elements (Çakır, Tozan and Vayvay, 2009; Labib, 2011).

The weight vector of the matrix A with n objectives is approximated as follows;

	$\mathbf{C_1}$	$\mathbf{C_2}$	…	$\mathbf{C_n}$
$\mathbf{C_1}$	w_1/w_1	w_1/w_2	…	w_1/w_n
$\mathbf{C_2}$	w_2/w_1	…	…	…
⋮	⋮	⋮	⋮	⋮
$\mathbf{C_n}$	w_n/w_1	w_n/w_2	…	w_n/w_n

Here, $w_i > 0$, where $i = 1, 2, \dots, n$, denotes the weight of objective i. Then, the normalized matrix is generated by calculating the list of relative weights of the criteria, in which the sum of weights is taken as equal to 1; each column j in A is normalized such that $\sum_j a_{ij} = 1$.

normalize columns;

	C_1	C_2	…	C_n
C_1	w_1	w_1	…	w_1
C_2	w_2	…	…	…
⋮	⋮	⋮	⋮	⋮
C_n	w_n	…	…	w_n

In order to normalize the columns, the average value is computed for each row i in the matrix by the formula, $w_i = (1/n)\sum_j a_{ij}$. Here, w_i is the weight of the criterion i in weight vector $= [w_1, w_2, \dots, w_n]$. Then, eigenvector δ_{max}, which is the principal eigenvalue for the pairwise comparison matrix A, is calculated. This δ_{max} value is necessarily important to calculate and ensure the consistency of the judgment matrix (Labib, 2011).

4.4.2. Fuzzy Set Theory and Fuzzy AHP

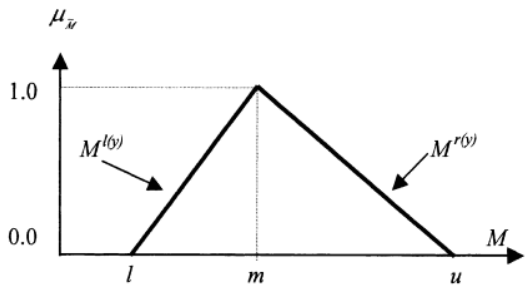
With subjective qualitative parameters, expressing preferences using exact numerical values is extremely challenging. This vagueness of human thought was first addressed by Zadeh (1965) as fuzzy set theory to offer a rationale for uncertainty arising from imprecision or vagueness. Its capability to represent vague data is the most important contribution of fuzzy set theory. Fuzzy set is a class of objects containing a continuum of grades of membership which is characterized by a membership function. A fuzzy number is a special fuzzy set which can be defined as $F = \{x, \mu_F(x), x \in R\}$, where x value ranges on real line $R_1 : -\infty < x < +\infty$ and $\mu_F(x)$ is a continuous mapping from R_1 to the close interval $[0,1]$.

In fuzzy AHP, the relative strength of the factors is indicated by utilizing fuzzy ratio scales, and final scopes of alternatives are represented by fuzzy numbers, which are then ranked to outline optimum alternative possible. The fuzzy numbers can be represented in different forms, such as standardized trapezoidal fuzzy number, or Gaussian method; however triangular member functions are mostly preferred as

they are easier to generate and evaluate (Lee et al., 2003; Chan and Kumar, 2007; Wang et al., 2012).

A triangular fuzzy number can be denoted by $\widetilde{M}$, where the symbol "$\sim$" represents a fuzzy set for a triangular fuzzy number. Its membership function, $\mu(x|\widetilde{M})$ assigns a grade of membership to each grade ranging between zero to one. Triangular fuzzy numbers (TFNs) are employed in order to characterize the fuzzy values of quantitative data, as it is easier to generate functions in applications. It can be denoted as $(l/m, m/u)$ or (l, m, u), where l represents the smallest value, m represents the most promising value and u represents the largest possible value in a fuzzy event (Mahmoodzadeh et al., 2007) (Figure 10).

Figure 10: Triangular Fuzzy Numbers



Source: Kahraman, Cebeci and Ulukan, 2003

It is important to note here that the cases where $l = m = u$, do not represent any fuzzy numbers (Chang, 1996).

The membership function of $\widetilde{M}$ in Figure 9, $\mu(x|\widetilde{M})$ can be defined as (Saaty, 1980; Kahraman, Cebeci and Ulukan, 2003);

$$\mu(x|\widetilde{M}) = \begin{cases} 0 & x < l \text{ or } x > u, \\ (x-l)/(m-l), & l \le x \le m, \\ (u-x)/(u-m), & m \le x \le u. \end{cases}$$

A fuzzy number has its left $(l(y))$ and right $(r(y))$ hand side representation of each degree of membership, and always given accordingly as;

$\widetilde{M} = M^{l(y)}, M^{r(y)} = (l + (m - l)y, u + (m - u)y), y \in [0,1]$

The fundamental laws for the operations between the two fuzzy numbers are as follows (Kaufmann and Gupta, 1991):

$M_1 + M_2 = (l_1 + l_2, m_1 + m_2, u_1 + u_2),$
$M_1 \oplus M_2 = (l_1 l_2, m_1 m_2, u_1 u_2),$
$\lambda \oplus M_1 = (\lambda l_1, \lambda m_1, \lambda u_1),\ \lambda > 0,\ \lambda \in R,$
$M_1^{-1} = (1/l_1, 1/m_1, 1/u_1).$

As AHP is based on expert opinion, it may not be possible to assign integer values while comparing the alternatives. Therefore, linguistic terms are also used in approximate reasoning (Lee et al., 2003; Chan and Kumar, 2007; Wang et al., 2012). It was also been criticized for not incorporating the uncertainties (Deng, 1999). Fuzzy AHP adds fuzzy logic on AHP, eliminates those shortcomings by taking the fuzziness of decision-makers into account and, extends Saaty's AHP. It can therefore be considered as a synthetic extension of traditional AHP method.

4.4.2.1. Fuzzy AHP

In Fuzzy AHP calculations, first the fuzzy synthetic value is calculated by (Mahmoodzadeh et al., 2007:138);

the object set $X = \{x_1, x_2, x_3, \dots, x_n\}$,
the goal set $B = \{b_1, b_2, b_3, \dots, b_t\}$ and

the TFNs for each goal g_i is represented by $M_{g_i}^j\ (j = 1,2, \dots, t)$ such that,

$M_{g_i}^1, M_{g_i}^2, \dots, M_{g_i}^t \quad i = 1,2, \dots, n.$

This can therefore be represented as;

$$S_i = \sum_{j=1}^{t} M_{g_i}^{j} \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{t} M_{g_i}^{j}\right]^{-1}$$ Equation 4.1

$\sum_{j=1}^{t} M_{g_i}^{j}$ is obtained by performing the fuzzy addition operation of t values for a particular matrix such that,

$$\sum_{j=1}^{t} M_{g_i}^{j} = \left(\sum_{j=1}^{t} l_j, \sum_{j=1}^{t} m_j \sum_{j=1}^{t} u_j\right)$$ Equation 4.2

while $\left[\sum_{i=1}^{n} \sum_{j=1}^{t} M_{g_i}^{j}\right]^{-1}$ is obtained by performing the fuzzy addition operation of $M_{g_i}^{j}$ $(j = 1,2,\ldots,t)$ values such that,

$$\sum_{i=1}^{n} \sum_{j=1}^{t} M_{g_i}^{j} = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i \sum_{i=1}^{n} u_i\right)$$ Equation 4.3

The inverse vector $\left[\sum_{i=1}^{n} \sum_{j=1}^{t} M_{g_i}^{j}\right]^{-1}$ is then computed by,

$$\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}$$ Equation 4.4

(Saaty, 1980; Chang, 1996; Kahraman, Cebeci and Ulukan, 2003)

The fuzzy synthetic values are then defuzzified into crisp values. In defuzzification, a specific crisp element is selected based on the output fuzzy set, and fuzzy numbers are also converted into crisp scores (Chen and Hwang, 1992; Yager and Filev, 1994). There are different methods employed in the defuzzification process. The two most commonly used are Yager and Filev (1994)'s Center of Area (Centroid) method, and Chen and Hwang (1992)'s method. In this research, defuzzification is made by following Opricovic and Tzeng (2003)'s method for converting the fuzzy data into crisp values (CFCS), which is developed in a similar way to Chen and Hwang (1992)'s fundamental CFCS method. Here, a procedure similar to the approach of determining the left and right score by fuzzy min and fuzzy max is followed to determine the corresponding fuzzy scores as crisp numbers. Then, the total score is determined as a weighted average with respect to the membership functions.

In Chen and Hwang (1992)'s method, for every *i*-th criterion, alternatives are evaluated with fuzzy numbers $\tilde{f}_{ij}$ for $j = 1,2, \dots, J$, and J is the number of alternatives. The TFNs for this set is $\tilde{f}_{ij} = (l_{ij}, m_{ij}, u_{ij}), j = 1,2, \dots, J$ and *i*-th (one) criterion are included in the defuzzification computation. The algorithm to determine the crisp values for the *i*-th criterion is employed in four steps;

1. Normalization:

$u_i^{max} = \max_j u_{ij}, l_i^{min} = \min_j l_{ij}$ Equation 4.5

$\Delta_{min}^{max} = u_i^{max} - l_i^{min}$ Equation 4.6

compute for all criteria $n_j, j = 1, 2, \dots, J$.

$x_{lj} = (l_{ij} - l_i^{min})/\Delta_{min}^{max}$ Equation 4.7

$x_{mj} = (m_{ij} - l_i^{min})/\Delta_{min}^{max}$ Equation 4.8

$x_{uj} = (u_{ij} - l_i^{min})/\Delta_{min}^{max}$ Equation 4.9

2. Compute left (*ls*) and right (*us*) normalized values, for $j = 1, 2, \dots, J$.

$x_j^{ls} = x_{mj}/(1 + x_{mj} - x_{lj})$ Equation 4.10

$x_j^{us} = x_{uj}/(1 + x_{uj} - x_{mj})$ Equation 4.11

3. Compute total normalized crisp value, for $j = 1, 2, \dots, J$.

$x_j^{crisp} = [x_j^{ls}(1 - x_j^{ls}) + x_j^{us} x_j^{us}]/1 - x_j^{us} + x_j^{us}$ Equation 4.12

4. Compute crisp values for $j = 1, 2, \dots, J$.

$f_{ij} = l_i^{min} + x_j^{crisp} \Delta_{min}^{max}$. Equation 4.13

This computation is done for all criteria, $\tilde{f}_{ij}, i \in \tilde{n}$. Here, $\tilde{n}$ denotes the set of criteria evaluated with fuzzy numbers (Opricovic and Tzeng, 2003).

4.4.2.2. Extent Analysis of Fuzzy AHP

There are several fuzzy AHP methods employed which utilize fuzzy set theory and hierarchical structure analysis (Kahraman, Cebeci and Ulukan, 2003). Other than defuzzifying the fuzzy values into crisp values by CFCS method of Opricovic and Tzeng (2003), it is also possible to follow the extent analysis method of Chang (1996) in which first each object is taken, then extent analysis for each goal, g_i, is performed.

For this, the previous calculation, $S_i = \sum_{j=1}^{t} M_{g_i}^{j} \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{t} M_{g_i}^{j}\right]^{-1}$, is followed by the below algorithm for employing an extent analysis methodology of Chang (1996);

The degree of possibility of $M_1 \geq M_2$ is defined as:

$$V(M_1 \geq M_2) = \sup_{x \geq y} \left[\min \left(\mu_{M_1}(x), \mu_{M_2}(y)\right)\right] \qquad \text{Equation 4.14}$$

When a pair (x, y) exists such that $x \geq y$ and $\mu_{M_1}(x) = \mu_{M_2}(y)$, then we have $V(M_1 \geq M_2) = 1$.

Since M_1 and M_2 are convex fuzzy numbers we have that:

$$V(M_1 \geq M_2) = 1 \qquad \text{if } m_1 \geq m_2 \qquad \text{Equation 4.15}$$

$$V(M_1 \geq M_2) = hgt(M_1 \cap M_2) = \mu_{M_1}(d) \qquad \text{Equation 4.16}$$

Where d is the ordinate of the highest intersection point D between μ_{M_1} and μ_{M_2}.

When $M_1 = l_1, m_1, u_1$ and $M_2 = l_2, m_2, u_2$, the ordinate of D is given by:

$$V(M_1 \geq M_2) = hgt(M_1 \cap M_2) = \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}$$ Equation 4.17

To compare M_1 and M_2, we need both the values of $V(M_1 \geq M_2)$ and $V(M_2 \geq M_1)$. The degree possibility for a convex fuzzy number to be greater than z convex fuzzy numbers M_i $(i = 1, 2, \dots, k)$ can be defined by:

$V(M \geq M_1, M_2, \dots, M_k) = V[(M \geq M_1)$ $(M \geq M_2)$ and … and $(M \geq M_k) = minV(M \geq M_i), i = 1, 2, \dots, k.$ Equation 4.18

Assume that;

$$d'(A_i) = \min V\ S_i \geq S_z$$ Equation 4.19

For $k = 1, 2, \dots, n; k \neq i$. Then the weight vector is given by:

$$W' = \left(d'(A_1), d'(A_2), \dots d'(A_n)\right)^T$$ Equation 4.20

where $A_i (i = 1, 2, \dots, n)$ are n elements. Via normalization, the normalized weight vectors are:

$$W = d(A_1), d(A_2), \dots, d(A_n)^T$$ Equation 4.21

where W is a non-fuzzy number.

4.4.3. Sampling of Fuzzy AHP

The sampling of Fuzzy AHP is determined from the experts in the multiple-case study sample group, by which the interviews were made.

The sampling is again made through purposeful sampling. Twelve of the forty one respondents, who provided rich and detailed information during the interviews, were selected.

It has been given greatest attention to determine the respondents from various levels of different types of food supply chains, two of which were selected among the consumers. Other three were selected from the QC managers in meat, dairy products and fish supply chains. Besides, logistics manager in distribution center of meat supply chain, sales manager in fish supply chain, one academician, general manager of food quality laboratory, as well as the experts in vessel, air and road transportation companies were also involved in the research. Each respondent has provided rankings on the pairwise comparisons of given criteria (Appendix 2), and the analyses were derived based on the data provided.

4.4.4. Measurement of Consistency

AHP methodology allows for non-consistent pairwise comparisons. Thus, it is critically important to measure and report the consistency ratio (CR), and ensure that the degree of consistency is satisfactory to confirm that the AHP results are meaningful. Although perfect consistency rarely occurs, the pairwise comparisons in a judgment matrix can be considered as consistent if the corresponding CR is less than 10% (Saaty, 1980). Although the acceptable CR range is 0.1 for all matrices above 5 ($n \geq 5$), it varies for smaller values; i.e. 0.05 for 3 x 3 matrix, 0.08 for 4 x 4 matrix (Saaty, 1980). In cases where CR value is greater than that value, judgments are considered to be inconsistent, and this necessitates improvement in the evaluation process.

In consistency calculations, a matrix of relative rankings for each level of hierarchy is generated by pairwise comparisons, in which the numbers of matrices vary with the number of elements at each level. It is then necessary to calculate the eigenvectors or the relative weights, global weights and the maximum eigenvalue (δ_{max}) for each matrix.

Therefore, first consistency index (CI) is estimated by calculating the eigenvectors or relative weights and δ_{max} for each matrix of alternatives of criterion

n. One critical validating parameter in AHP is δ_{max} value, which is used as a reference index in calculating the CR (Saaty, 1980; Haq and Kannan, 2006; Labib, 2011).

$$\delta_{max} = \frac{1}{n}\sum_{i=1}^{n} \frac{ith\ entry\ in\ Aw}{ith\ entry\ in\ w} \qquad \text{Equation 4.22}$$

Then, CI is calculated for each matrix by the following formulae;

$$CI = \frac{\delta_{max} - n}{n-1} \qquad \text{Equation 4.23}$$

Later, CI is divided by random index (RI) value to calculate the CR.

$$CR = \frac{CI}{RI} \qquad \text{Equation 4.24}$$

RI is the average value of CI for randomly chosen entries in A, which is obtained from a large number of simulation runs; thus it depends on the number of criterion. The value of RI for matrices with 1 to 10 criterions is shown in Table 11:

Table 11: Average Random Index (RI) based on matrix size

N	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
RCI	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

Source: Saaty, 1980

Then, the decision alternatives within each criterion are compared with each other in order to derive the individual priority vectors, which then become the columns of the decision matrix. Also, by using pairwise comparisons, the weights of importance of the criteria are determined and matrices for the alternatives will be created by the decision maker. This is to determine a decision matrix with final priorities of alternatives for all criteria.

4.4.5. Fuzzy AHP as a Method to Integrate TBL Approach into Supply Chain Risk Factor Assessment

Fuzzy AHP is employed in different areas, including risk (Chan and Kumar, 2007; Wang et al., 2012), and sustainability (Shaw et al., 2012; Wittstruck and Teuteberg, 2012; Shen et al., 2013). Several problems are also approached by fuzzy AHP, e.g. service company comparisons (Kahraman, Cebeci and Ulukan, 2003), supplier selection in supply chains (Kahraman, Cebeci and Ulukan, 2003; Haq and Kannan, 2006; Chan et al, 2008; Kazançoğlu and Ada, 2010; Labib, 2011; Yücenur, Vayvay and Demirel, 2011; Shaw et al., 2012; Wittstruck and Teuteberg, 2012), logistics service provider selection (Çakır, Tozan and Vayvay, 2009); project selection (Mahmoodzadeh et al., 2007; Huang, Chu and Chiang, 2008). However, a new perspective unique to this current research involves utilizing fuzzy AHP in sustainability and risk areas, to outline how the relative importance of risk factors in supply chains differ in terms of their impacts on economic, environmental and social sustainability-related hazards, and compare the fuzzy AHP results of the three dimensions in order to propose a pathway to develop sustainability-oriented supply chain risk management. This perspective might also be considered as a contribution to fuzzy AHP literature, which incorporates the sustainability area through this methodological approach, in terms of integrating its different TBL dimensions.

The fuzzy approach in this study is adopted on a qualitative risk evaluation to transform their sustainability impacts into fuzzy values, and consequently into quantitative assessment outcomes for sustainability-oriented risk management framework. First, fuzzy AHP was employed separately for all three dimensions of sustainability, after which the fuzzy values were defuzzified through Opricovic and Tzeng (2003)'s CFCS methodology. Then, the same analysis was made, this time by Chang (1996)'s extent fuzzy AHP method. The results were compared to validate the findings, and evaluations were made accordingly. This is the part where sustainability orientation on supply chain risk management was developed. The prioritization was made by fuzzy AHP for environmental, social and economic dimensions of sustainability for the risk factors, and the prioritization results were compared to determine whether different concerns exist for different dimensions.

Then, an evaluation was made to identify how a best focus in supply chain risks would address sustainability-related hazards in an integrated manner.

CHAPTER V
ANALYSIS AND RESULTS

The theoretical methodology presented in Figure 7 proposes an approach to assessing the sustainability orientation in supply chain risk management strategies. This theoretical approach was followed in order to address the fundamental aim of this study, which was implemented in food supply chains, and the results were discussed in order to develop a sustainability framework on risk management strategies.

Taking the theoretical perspective and the comprehensive literature review on the focus of the study, data was collected through a multiple-case study conducted in five different types of food supply chains. The data from semi-structured interviews and observations were then used to explore and code the risk factors in food supply chains, which were then verified by the references in the related literature through manifest content analysis. The outlined risk factors were analyzed for each case as well as across the cases, in order to determine risk factors addressed in each type of food supply chain and the differences of the emphasis on those risk factors across food supply chain types. The risk factors identified by the multiple-case study were presented in a conceptual model, which shows the contextual relationships and interactions among risk factors.

The main findings of multiple-case study were used to assess different strategic approaches, which might have been generated when risk factors are analyzed from environmental dimension, social dimension or economic dimension distinctively. The prioritization of the relative importance of the risk factors in terms of their impacts on environmental, social and economic dimensions of sustainability-related hazards was examined by Fuzzy AHP analysis.

The data, collected from a large sample at different phases of the multiple methodological approach, either by the literature based articles, theory driven propositions or by empirical research through semi-structured interviews, observations, latent and manifest content analysis, within, cross case analysis, ISM approaches and fuzzy AHP, all moved the framework of the study towards

crystallization (Richardson, 2000; Tracy, 2010). Therefore, the findings of the multiple methodological approaches provided voluminous data incorporating various members of supply chains at different stages, and proposed for strategies to be focused for developing sustainability framework on risk management strategies.

5.1. FINDINGS OF MULTIPLE-CASE STUDY

The fundamental question of this research asks how a sustainability-oriented food supply chain risk management can be developed. Therefore, here is a need for a focus on multiple exemplars of different types of food supply chains which represent the industry in general. The unit of analysis in this multiple case study research is *supply chain*. Therefore, data was collected from five cases selected among five different types of food supply chains, in which leaders from various levels of thirty-two organizations were interviewed (see Table 2). Data were collected between December 2013 and May 2014.

The number of cases in multiple case study research depends upon either the maximum amount of data that could be processed by a researcher (Eisenhardt, 1989) or on the saturation point that would be achieved with the data collected (Yin, 2009). In this research, the data collected from five cases of food supply chains has provided a satisfactory level of saturation, which also reached the limits of the amount of data that could be processed by the researcher.

A purposeful sampling approach was followed (Eisenhardt, 1989, Pagell, 2004) within food industry, because sustainability and risk are two key concerns for food industry logistics activities (Cavinato, 2004; Akkerman, Farahani, and Grunow, 2010), and there is the sensitivity of the logistics processes in food industry, at which the risks and sustainability practices would differ (Jüttner, 2005; Olson and Wu, 2010; Singhal, Agarwal and Mittal, 2011; Wognum et al., 2011). Therefore, the most important determinant in the sample selection was the type of the food products, and the experience of the related food brands in the market to ensure that the exemplars would provide rich information about the risks and sustainability practices in their industry. The companies in sample scope are privately owned firms, at different sizes, both large and small, in related food supply chain types. This is to provide a

comprehensive outline of the risks and sustainability practices, regardless of company size.

Facility tours and informal talks with the employees at twenty-eight sites were also enriched with data collected through the interviews, which provided an opportunity to match rhetoric information with real experiences.

The interviews with forty-one respondents were all conducted on site, and each lasted around 40 minutes. The interviews were recorded, transcribed, and checked for accuracy.

The interview schedule comprised of seven questions, most of which were open-ended, in order to address the key points necessary to explore the related research questions. Therefore, each one of the interview questions were determined based on the major aim and on the theoretical framework of the study (Appendix 1).

Coding of the data was based on the transcripts as well as the observation notes. Although the extensive literature review addressed to several risk factors and sustainability practices, the main aim in coding was to capture the risk factors and the sustainability practices that were not addressed in the literature. During the coding process, a back and forth scan between the cases was made. In the coding process, the scheme was enriched with each case, either by adding the risk factors to previously identified coding or by creating new coding.

An inter-rater agreement check was conducted, and three academicians from the field independently examined and analyzed transcript data to check whether the codes and themes were coded the same way as in the analysis (Berg, 2001; Creswell, 2007). The process forced 95% inter-rater reliability. Additional insight on debatable issues on different judgments were discussed by the independent coders, and later, an individual assessment of the causes leading to discrepancies was aligned by discussing the issues, a process which is referred to as "discursive alignment of interpretation" (Seuring and Gold, 2012:547).

5.1.1. Supply Chain Risk Factors Outlined in Multiple-Case Study

As a result of the multiple case study research, which was conducted in the five types of food supply chains, around twenty hours of recording was made during

forty one interviews and twenty eight site observations, conducted at thirty two companies. The questions were asked from a TBL perspective, and risk factors in different types of food supply chains were outlined.

The risk factors, which were revealed and coded, address to the second research question of this thesis study, aiming to explore the risk factors in food supply chains from a TBL perspective. Accordingly, twenty-three risk factors were identified during the course of coding the transcripts; namely the risk factors of complacency, capability, control, dependence, consciousness, ethics, governance, inertia, opportunism, employee, legality, health and safety, information, quality, resource, traceability, reputation, seasonality, stakeholder, self-focus, planning, structural, and perception.

5.1.1.1. Complacency Risk Factor

Complacency creates risk in a business (Prentice, 1998). This risk is basically arouses from the underestimation of risk (Kämpf and Haley, 2011) which refers to the belief that, as nothing bad has happened before, it will not happen now or after. Many companies prefer not to invest in a risk that never happened before, even though it has the probability to happen (Enyinda, Anaza and Hamouri, 2013). Complacency risk is defined from different perspectives in the literature; such as managerial reluctance to engage in strategic change from a managerial perspective (Rusetski and Lim, 2011); as a cause for vulnerability on supply network (Csillag, Lima Filho and Figueiredo, 2006); or as the risk of underperformance due to supply chain partnerships becoming too cosy (Leverick and Cooper, 1998) from a supply chain perspective.

In this research, respondents mentioned negligence, inertia or passivity of supply chain members related to various logistics operations, or towards other supply chain members. They argued that in food supply chains, members are open to making concession on health critical issues, neglect control at several logistics operations (e.g. temperature control in delivery process), and mainly focus on manufacturing speed to market, rather than on quality due to their complacency. Besides, it has also been discussed that problematic issues are not fixed, failures and

breakdowns are not resolved, or corrective and preventive actions are not taken satisfactorily, which, in the end, hinders continuous improvement and triggers inertia. Moreover, the underestimation of employee health and safety issues (e.g. not taking preventive actions in critical operations) is another indicator of negligence. On the other hand, the negligence of the upward chain members was emphasized frequently by the respondents; especially, the consumers and their activities are considered to be highly neglected. It has been highlighted that consumers are not sufficiently considered as a member of supply chains, and thus, are not controlled or informed enough. This negligence of consumers in food supply chains results in unconsciousness and passive consumers, who are not well aware, or who are reluctant to give their negative feedbacks, comments or inquiries on complaints.

The detailed probing on those discussions revealed that there are some implicit reasons for this negligence, inertia or passivity.

The respondent who was a grocery store in the sample mentioned that;

'one might see a consumer in store, who damages the coolness of products while shopping…'
'we see consumers who open the door of coolers and wait long in front, but we never want to warn them to keep politeness'.

This viewpoint of the grocery store, or the approach towards the consumers addressed to a cultural aspect which cannot be rationalized easily. Besides, when discussions were extended further, conventionalism, habits, fatalism, views and perceptions or unconsciousness, lack of awareness or lack of knowledge were explored as other aspects leading to negligence, inertia or passivity.

Those arguments show that, the discussions addressed to the underestimation of risks (Kämpf and Haley, 2011) and the belief that there is no potential for a risk to happen. Thus, it has been outlined that, *complacency*, here, leads to negligence, inertia or passivity, and in the end, triggering the risks related to various logistics operations, or various members of supply chains.

Therefore, in this research, the complacency risk factor was defined as any negligence, inertia or passivity of supply chain members that might have been caused

by some inherent aspects such as culture, habits, conventionalism, and fatalism, as well as by some learning aspects, such as lack of consciousness, awareness or knowledge. In the interviews, especially the inherent aspects were emphasized to cause complacency, more than the learning aspects.

5.1.1.2. Capability Risk Factor

The term capability refers to "the key role of strategic management in appropriately adapting, integrating and reconfiguring internal and external organizational skills, resources and functional competencies to meet the requirements of the changing environment" (Ifandoudas and Chapman, 2009:691). In the literature, capability risk is used to explain the failure to perform the complementary activities to reach to a desired level of performance, and falling far behind the target requirements. This gap between the actual and the required performances represent the lack of capability in performing necessary activities for achieving satisfaction at all levels (Tanrıverdi and Ruefli, 2004). It is mostly referred in, but not limited to, software (information technology) related studies (Tanrıverdi and Ruefli, 2004; Xie, Zhang and Lai, 2006), and basically addresses the question of *Can we do it?* (Sawhney, Balasubramanian and Krishnan, 2003).

Capability risks might either be a risk related to supplier capability to provide materials on time at the required quality, producing a direct impact on the end product quality and service (Sawhney Balasubramanian and Krishnan, 2003; Cui et al., 2007; Liu, Young and Ding, 2011), management capability, Research and Development (R&D) capability, technological capability (Jiang and Wang, 2007), or assets, experience, demand understanding (Xie, Zhang and Lai, 2006), operator inability (Wu, Xiang and Xiong, 2009), as well as the capability of interdependent activities blocking the operability of others, and hence the service capability to users (Sawhney Balasubramanian and Krishnan, 2003; Garvey and Pinto, 2009). Other than the service and user satisfaction, capability risks also have a substantial effect on sustainable innovativeness of the organization (Wu, Xiang and Xiong, 2009), or on the environmental, social and economic performance of firms (Paulraj, 2011).

In this research, respondents highlighted various problems or incapability related to logistics processes, such as implementing a first-in, first-out (FIFO) strategy in logistics processes (e.g. harvesting, manufacturing, distribution process), providing customized customer service, adopting risk-based product management, managing risk issues through a reactive approach (being unprepared for unexpected events), responsiveness or agility (especially, recovery in case of a technological failure), solving problematic issues, taking corrective or preventive actions, following and adopting worldwide advancements, R&D activities, quality issues and leaning the processes (number of people involved in a task, analysis made, duplicated workloads), employee performances (e.g. attention), collaborating, especially with international customers, retaining continuous improvement, avoiding inertia, innovation, management of multimodal transportation processes, managing supply chain members due to their limited qualifications (e.g. equipment, facility or packaging methods or materials), adopting technological advancements, managerial competence (managerial expertise, experience and capability), and efficiency (e.g. of processes, products, supply, transportation). Besides, they also emphasized incapability related to employee management resulting in employee adaptation problems or resistance of employees towards change or innovation. Furthermore, other financial incapability were also mentioned, resulting from false pricing strategies, investment decisions with long return of investment periods, and price discount pressures by other stakeholders, which triggers the cost concern of related members.

They further argued that, such incapability lead to problems in logistics operations, especially in cold logistics, or lead to technological non-competence and technological incapability also in terms of environmental issues (e.g. in managing water or energy consumption). Such incapability are considered to result in brand de-valuation, loss of reputation, loss of value, loss of customers (especially the international customers), loss of market share, which in the end results in serious financial problems, non-competitiveness, or even bankruptcy, and thus, lack of sustainability in supply chains.

Above discussions addressed to the need to define capability risk factor distinctively in this research. By following the definitions of Tanrıverdi and Ruefli

(2004), and Ifandoudas and Chapman (2009), capability risk factor was defined as being any issue that might prevent a supply chain from adopting, integrating and reconfiguring internal and external organizational skills, resources and functional competencies, to meet the requirements of the changing environment and fail them to achieve a desired level of performance.

5.1.1.3. Control Risk Factor

Control is necessarily important for supply chain confidence and resilience (Jüttner, Peck and Christopher, 2003; Christopher and Lee, 2004; Jüttner, 2005). It is mostly referred as one of the most critical strategies for mitigating the risks in supply chains (Jüttner, Peck and Christopher, 2003; Jüttner, 2005; Manuj and Mentzer, 2008) to ensure that the given rules, policies or procedures to govern supply chain processes are adopted (Christopher and Lee, 2004). The risk here is the lack of control, representing the probability that important errors will not be detected, will negatively affect the complete performance of the supply chain (Christopher and Lee, 2004; Albersmeier et al., 2009), and this issue is frequently and explicitly addressed in the literature (Jüttner, Peck and Christopher, 2003; Christopher and Lee, 2004; Christopher and Peck, 2004).

In this research, respondents frequently mentioned control related risk factors. Difficulties in control of both downward (e.g. subcontractors, internal operations of suppliers, small-medium sized enterprises) and upward (e.g. consumer activities) tiers, or employees are considered to be obviously challenging. Besides, poorly managed control and audit processes arising from various aspects, e.g. deception of auditors or, deliberate negligence by suppliers, restaurants, and dealers, fraud or opportunistic behavior, were also highlighted to be leading to risk factors related to control. Moreover, control related risk factor can result in problems in other logistics activities, e.g. poor control in product sampling process, delivery process, disposal process of products, warehouse operations (temperature control, employee left inside the warehouses, open doors of warehouses…etc.), equipment, heat treatment processes, packaging control, tracking of temperature variations or additives of products (even after packaged), shelf life and expiration date follow up of products,

hygiene, as well as in some supply chain members, such as performance of suppliers, employees or upwards chain members (especially, small sized markets, groceries, restaurants). On the other hand, governmental control or close supervision by governmental bodies and interdependent control were mentioned as being critically important, which might lead to control risk factors if they are misled. There are also some other processes which are considered to be hard to control and therefore might lead to some risks, such as distribution process or other manually handled processes (e.g. manual packaging), or the ingredient check process where the exact ingredients in a product are identified (e.g. identification of raw material quantity).

Control risk factors were also associated with the cost related factors (cost of making an audit or making related tests to identify additives), or structural factors related to long distance distribution networks in the interviews. Besides, long durations at transshipment or control nodes, especially in hot seasons (including port, customs, retailers, and delivery nodes) were also regarded as leading to control risk factors. Moreover, manual controls made by the labors, lack of proactive involvement of end sales points, non-report of deficiencies or problems, non-existence of risk-based raw material quality control, non-follow up of natural resource consumption, mismanagement of green performance, lack of availability of veterinary control in critical logistics processes, or at critical sales nodes (e.g. at handling points, input control to realize if any hidden disease exist, parallel control of live-stock carcass with other meat, also at retailers), the probability of property loss which might damage the product, are some other aspects raised during the interviews, all of which are caused by a problem related to control.

One interesting comment was made by a retailer who emphasized self-focus and poor scope performance management and audit system by;

‘*scopes of the audits are only covering big chain members, most of the suppliers are not controlled*’.

Other respondents also commented that;

‘*every member controls its direct contact only*’,

‘*it is impossible to control every subcontractor or every individual sales node*’.

The above discussed issues were explained to result in hygiene problems, contagious disease (e.g. carried by employees, other outsiders or by live-stock), mismanagement of market nodes (especially of retail chains, markets, restaurants), accidents, consumers damaging the quality of products (e.g. replacing food products after a long tour in the market), perishing of products in consumer transport, poor performance management, poor supply chain control and audits, poor sustainability performance management, problems in operations management (e.g. ports), quality and quality control problems (especially raw materials, packaging of raw materials), problems in securing the coolness of products in cold logistics processes (especially while handling, loading or unloading, packaging, distribution and other operational process). Also, there were some other specific issues mentioned, such as difficulties in controlling problems related with the nature of the problems (e.g. dead fish).

The arguments of the respondents all addressed the risk of lack of control (Christopher and Lee, 2004; Albersmeier et al., 2009), and the potential consequences that might arise if important errors were not detected. This scope is defined in this research accordingly as *control risk factors*.

5.1.1.4. Dependence Risk Factor

Dependence is a natural outcome of buyer-supplier relationships (Wagner and Bode, 2006). Although in the literature, dependence is referred to as the interdependence of supply chain partners building a long term relationship orientation and collaboration (Mentzer et al., 2001; Matopoulos et al., 2007), it is also mentioned as a source of exposure to risk, especially with the growing complexity of supply chain setups (Christopher and Peck, 2004; Wagner and Bode, 2006; Matopoulos et al., 2007). Dependence risk can be defined as the concern of underperformance, strongly effected either in case of a failure or negativity at a supply chain member such as supplier, customer (Hallikas et al., 2005; Wagner and Bode, 2006; Liao, Liao and Hutchinson, 2009; Tsai et al., 2012) or at a process, system or asset, such as source/supply, transit systems and facility (Li et al., 2014). It might be lead to control problems as well, or triggering other risks of loss of

incentive for competitiveness, or the risk of relative power and opportunism (Clark, 1961; Ellram and Billington, 2001; Matopoulos et al., 2007).

In this research, dependence was mentioned from various aspects in the interviews. It was mentioned as external dependences, such as to economic fluctuations (e.g. economic fluctuations in import-export, exchange rate changes, frequent raw material price fluctuations, product prices fluctuations, competitor's pricing policies), which create financial dependence; also as regulatory changes (e.g. changes in ingredient amounts, meat and chicken rates in products or in production lines, labeling, waste reuse, harvesting or halal slaughter with a concern for live-stock welfare), or destination and transfer country regulations, which creates regulatory dependence; and also as global downturn or terrorism, which creates economic dependency or security issues. Theft was another aspect referred as leading to security issues. Besides, it was also mentioned as dependence related risk factors, such as labor performance (expertise, experience, awareness), which could lead to labor dependence; quality dependence on especially initial (internal) processes (e.g. farming, harvesting), which could lead to quality problems and create quality dependency. Dependence on nature (e.g. natural disasters, weather conditions, natural phenomena, natural attacks caused by wild fish) was another aspect emphasized by the respondents. There is the dependence on live-stock, live-stock growth process, live-stock harvesting process, and live-stock dispatch process, all mentioned for ensuring live-stock quality, raw material quality, and thus product quality at all stages.

Therefore, *dependence risk factors* were associated with the sources for exposure to risks, especially with the growing complexity of supply chain setups (Christopher and Peck, 2004; Wagner and Bode, 2006; Matopoulos et al., 2007), and in case of a failure or negativity at a supply chain member (Hallikas et al., 2005; Wagner and Bode, 2006; Liao, Liao and Hutchinson, 2009; Tsai et al., 2012), or a process, system, asset, transit systems and facility (Li et al., 2014). These factors were defined from a broader perspective in this research, as associated with larger forces addressing a failure or negativity of a system effect, which could be related to either an external or an internal aspect.

5.1.1.5. Consciousness Risk Factor

Consciousness can be defined as the awareness of awareness, which emphasizes the idea of exception, rather than the rule of cognition (Zaltman, 2000). Thus, it is the combined product of instincts, values, beliefs, experiences, information, knowledge, awareness, emotions…etc., which reinforces the behavior and organizing power of individuals towards performing a task. It reflects effect of the past experiences on future behaviors, and also fosters attention (Zaltman, 2000; Gustavsson, 2001).

The importance of consciousness is addressed in terms of many aspects, including different supply chain members, such as consumers (Zaltman, 2000; Raynolds, 2004; Vernuccio, Cozzolino and Michelini, 2010), employees (Zeng et al., 2010) or management (Chowdhury et al., 2012), organizations (Pees, Hostetter Shoop and Ziegenfuss, 2009) and marketing (Kotler, 1972).

During the interviews, respondents addressed issues related to consciousness in their discussions. Especially, consumers were the focus of emphasis; in other words, the lack of consciousness of consumers was highlighted at almost every stage of discussions. Some issues which were argued to cause a lack of consciousness were, negligence of complete education, negligence of training, negligence of awareness-raising training on hygiene, negligence of consumer awareness, and consciousness-raising efforts of other supply chain members, as well as non-exposure of people to any health threat, misinformation (e.g. of unproven insanitariness), resulting in unaware consumers, leading to misperception of consumers, or creating quality-indifferent consumers. There is, then, the non-inherence or non-acceptance of knowledge (esp. on cooling standards and hygiene). As a result, consumers were considered to be following personal or public judgments rather than true knowledge (e.g. legal). Besides, other examples emphasizing consumer related consciousness issues discussed by respondents include consumers' cost concern rather than quality, poor kitchen or storage conditions by householders which can lead to cross contamination (especially in terms of hygiene and temperature), unconsciousness of consumers on waste management issues, non-demanding consumers especially on legalized (certified), qualified products or production, as well as their inattention on

the information on packaging (e.g. on shelf life, name of the producer, storage conditions, shelf life information varying based on the storage conditions). This lack of consciousness of consumers was also associated with some other factors in the discussions, such as difference in income levels of consumers or regional difference in awareness levels of consumers.

Besides, the unconsciousness of downward chain members (especially live-stock raisers), employees (especially the drivers) and upward chain members (especially dealers, markets, groceries) or of other stakeholders was also strongly highlighted. Here, lack of technical knowledge of related supply chain members (especially employees or managers), negligence of repair and maintenance issues (e.g. isolation, renovation, and calibration), as well as lack of knowledge and awareness on the seriousness of time constraint, or lack of knowledge and awareness on waste management issues, were emphasized. This problem was further associated with several problems in logistics processes, especially when there is the lack of knowledge and attention on methodologies in initial processes (e.g. harvesting, farming or butchery), appropriate technologies (especially in initial processes), lack of awareness on live-stock welfare, lack of knowledge on and attention to packaging methods and materials, as well as on shelf life and temperature constraints in facility conditions, and on the importance of temperature levels in logistics processes (especially in harvesting, farm, handling, loading and unloading, packaging, distribution and other operational processes). The criticality of initial processes was frequently highlighted by the respondents;

'*Harvesting process is the most important part of the whole chain*'.
'*..is where the real quality of the product at the point of consumption is maintained*'.
'*..the most riskiest part of the supply chain*'

Besides, this lack of consciousness of supply chain members leads to poor audit effectiveness and performance or negligence of control and auditing (especially in upward and downward tiers), negligence of employee health and safety issues, negligence of logistics operations in cold or hygienic concerns, negligence of opportunistic behavior, as well as less rigorous attitudes, which result in incomplete

evaluation on audits and controls, or sanctions given only to big chain members. However, lack of knowledge and awareness on the seriousness of the impact on human health was considered to be a critical trigger for or consequence of several other factors. This lack of awareness on catastrophic consequences was emphasized by different respondents. Moreover, lack of knowledge and awareness on the importance of food safety was also mentioned in the discussions. Problems in heat treatment process or lack of knowledge on cooking standards were all considered to arise from consciousness-related factors. Besides, it has been emphasized that, as a result of unconsciousness, supply chain members neglect critical processes, (e.g. combine different temperature or different type of products in a single vehicle, which threatens food safety), and thus trigger hygiene problems or growth of bacteria. Accordingly, they face problems in maintaining the cold chain from the very initial phase up until the sales points.

One respondent emphasized that,

'*in a fish market, cooling of fish is made with ice only, even during hot summer seasons*'.

Besides, lack of knowledge on destination or transfer country regulations or lack of knowledge in supplier practices, were also highlighted as leading to problems in logistics processes. Lack of consciousness, knowledge and attention also were emphasized to be resulting in problems in other logistics operations, such as, misjudgment of a potential additive in a product, or lack of knowledge on the difference between shelf life and expiration date, lack of awareness on, or negligence of the importance of being on-time for shelf life and cold chain concerns, and negligence of transportation mode-specific packaging (especially to ensure temperature stability at consumer transportation). There is, therefore, always a risk of harm from hazardous practices due to unconsciousness.

As emphasized by the respondents, there was also the lack of consciousness, knowledge and attention on sustainability issues associated with the unawareness on the positive return of social and environmental efforts, which eventually results in

immaturity or late maturity of sustainability concept (especially regarding water/energy consumption), or concludes with supply chain members which do not approach to sustainability issues from a TBL perspective. Accordingly, sustainability audit consideration was considered to be highly neglected in supplier performance reviews, and social responsibility projects were also emphasized as omitted.

The risk in terms of consciousness is mostly referred in the literature in terms of lack of consciousness of several supply chain members (including employees, consumers, and organizations), as being the source of negativities in various issues (Ozorhon, Dikmen and Birgonul, 2005; Kooijmans and Flores-Palacios, 2014; Sitnikov and Bocean, 2014). The discussions here, on lack of knowledge, attention or the negligence on critical issues were all far more than awareness only (Zaltman, 2000). There is the inherence of that exception of awareness, which addresses to unconsciousness. Therefore, all those discussions were referred as *consciousness risk factors* in this research.

5.1.1.6. Ethics Risk Factor

Ethics refers to morality, conduct, honesty, fairness, integrity, equity, legitimacy and compliance to promote welfare of the public, as well as of the organizations (Walker and Rowlinson, 2007). An ethical violation in any member of the supply chain affects other members or businesses in a negative way. Thus, ethics or compliance violation is defined as the ethics risk in the literature (Neef, 2005; Levin, 2007; Chen et al., 2013). Especially, supplier-related ethics risks are considered to be the most damaging among all others, leading to a failure in supply chain corporate integrity, with a direct impact on customers (Neef, 2005; Levin, 2007). Therefore, ethics risk should not be ignored, and needs to be managed to avoid reputation damage (Zablow, 2006), for business survival (Levin, 2007) and for competitiveness (Özlen, Tulić and Čengić, 2013).

In this research, ethics risk factors were outlined from the discussions. The arguments showed that these mainly result from some factors such as culture, consumer psychology, competition, fatalism, complacency, nepotism, and human psychology triggering the defense mechanism, violation of ethics in supply chain

logistics operations or among supply chain members. These violations result in many problems, such as corruption, intention to deceive, customer discrimination, non-reliability of certifications, consumers making unfair claim by false or groundless accusations, supply chain members' recrimination by false or groundless accusation, sales or marketing of additive products, misrepresentation of true condition, untitled complaints, unfair exposure to public, unfair exposure of incorrect information to media, unfair incentives, nepotism by acquaintance, nepotism by relationships, non-reliability of promises given to consumers, distrust, deliberate negligence of labor, poor performance in social sustainability, negligence of employee rights, negligence of live-stock welfare, public with poor nutrition habits, unhealthy product portfolios, and more importantly, health and safety problems.

'*quality products are sold to big customers or retail chains, and low quality products to end consumers at market'*.

Therefore, within the scope of this research, any activity which violates ethics or compliance (Neef, 2005; Levin, 2007; Chen et al., 2013) was classified under *ethics risk factors*.

5.1.1.7. Governance Risk Factor

Different from the official governance performed by the government, governance involves all other players in a broad range of different systems of institutions with both formal and informal interactions (Shiroyama et al., 2012). Governance risk is considered within a broad framework of strategic risk assessment carried out by the managers, directors and related leaders (Paladino, Cuy and Frigo, 2009; Frigo and Anderson, 2011). It refers basically to the failure in management or control (Von Kanel at al., 2010), and in alignment to the culture and strategy resulting directly from the approach of governance driven by the management (Tucker, 2011). Governance is very important also from a sustainability perspective. Supply management governance helps to improve the resilience of supply chains, which at the end provides sustainability (Eltantawy, 2011).

In the research, discussions addressing to governance related risk factors emphasized different approaches. Issues related to failure of governance or management control include insufficiency of regulations, lack of systematic and formal governance, insufficiency of governmental incentives, insufficiency of legal obligations for certifications or for licensed employees, non-commitment by management, poor organizational policies, poor policies for efficient supply (especially true policy setting for efficient supply), lack of green incentives. This failure of management control was also argued to result in negligence of supplier performance reviews, false selection of suppliers, mismanagement of waste (e.g. wrong methodologies applied in disposal of products or in waste disposal), negligence of recycling and rework efforts, or negligence of sustainability concerns (especially in outsourcing decisions; local versus global sourcing or in-house versus outsource). All such issues or negligence led to negative consequences, such as non-existence of supplier classification, or audit treatments based on risk performances, complaint mismanagement, problems in green management, problems in local state governance, pollution (e.g. feed at sea, defecate risk, fuel leakage, sea pollution, including environmental pollution, ecosystem), and self-focus governance by individual supply chain members, which in the end resulted in inflexible supply chains, and thus unsustainable supply chains.

Especially this self-focus perspective and inflexibilities related to poor governance was argued by some respondents;

‘*organizations are not structured as supply chains, individual concerns are in priority rather than the holistic concerns*’
‘*supply chains are not flexible enough to cope with unexpected events, even if everything is planned perfectly, and if your supply chain is not flexible, you are condensed to fail*’

Various comments are made by the respondents in terms of waste management;

‘*in fish chains, there is weak waste management, especially at restaurant side*’

‘*unsold fish is reused as feed, but fish waste is not re-valued*’
‘*waste is chuck-out instead of reuse or disposal*’
‘*water and packaging reuse is not a common practice in food supply chains*’

Based on those arguments, the failures in management or control (Von Kanel at al., 2010) were considered to result in factors leading to risk, and therefore referred in this research as *governance risk factors*.

5.1.1.8. Inertia Risk Factor

Inertia risk refers to the incapability and resistance of organizations to respond, react and adapt to changes or competitor acts (Fawcett and Magnan; 2001; Jüttner, Peck and Christopher, 2003). This can take different forms, such as managerial, organizational inertia (Simatupang and Sridharan, 2002; Smith, Lancioni and Oliva, 2005) as well as individual inertia, which also leads to a risk-averse behavior especially in management (Sitkin and Pablo, 1992). Inertia risk would result in problems in supply chain integration (Fawcett and Magnan; 2001), reduce the efficiency, while increasing logistics costs, and leading to loss of revenue (Smith, Lancioni and Oliva, 2005).

In this research, respondents mentioned inertia while explaining several tasks. However, rather than only being associated with a particular task, inertia itself was emphatically mentioned as a risk factor in the discussions. This inertia was explained as resulting from various aspects related to culture, fatalism, consciousness and awareness, all of which led to resistance to continuous improvement, not following and adopting into worldwide advancements, poor R&D and quality efforts, and non-implementation of knowledge, negligence of training or negligence on several other logistics operations (e.g. R&D efforts in green packaging design or packaging materials), as well as inertia on sustainability issues also leading to mismanagement of green performance.

Therefore, here in this research, this incapability and resistance of organizations to change (Fawcett and Magnan; 2001; Jüttner, Peck and Christopher, 2003) were entitled as *inertia risk factors*.

5.1.1.9. Opportunism Risk Factor

The vulnerability of supply chains towards opportunistic behavior is growing in recent years, and therefore is frequently mentioned in the literature (Robson, Paparoidamis and Ginoglu, 2003; Cruz and Liu, 2011). It is basically explained as the lack of honesty and as a problem of ethics, trust and commitment. Moreover, bounded rationality, especially due to the lack of transparency, produces opportunistic behaviors (Carter and Easton, 2011). Opportunism risk refers to the potential for a selfish act of a supply chain partner, by veiling or distorting information, even by misleading, cheating or confusing other partners on purpose, for self-interest or for deriving an unfair gain of profit (Williamson, 1975).

In the research, respondents highlighted issues related to misuse or abuse of governmental incentives, nepotism (e.g. in certifications, agreements, licensing), violation of certification standards, or problems in satisfying the certification standards, as well as the opportunistic behavior of customers or consumers, subcontractors and opportunism in logistics processes (e.g. feed processing, feed planning, product disposal process, live-stock growth process, and live-stock supply, supply process of baby fish, imported chicken). Besides, they also explained some issues which relates to opportunistic behaviors of supply chain members, such as adding shelf life expired products into the blends of others, using defective raw materials in blend (including unhealthy additives to avoid microorganism reproduction), using illegal doses of chemical ingredients to increase durability of products, freezing shelf life risky products and selling them at a low price, allowing for live-stock mutation or artificiality (especially in chicken supply chains), live-stock ventilation, illumination, fumigation of eggs, reserve and use of illegal additives by some members, live-stock vaccination for commercial greed, purposely ignorance of critical processes (e.g. in fish harvesting process), using low quality raw material, using inappropriate quantity of raw material, sales of cold chain broken or shelf life (almost) expired and damaged products, offering for promotions on shelf life period limited products, sales and marketing of additive products (especially to children), and unfair returns from sales points. Although frequently mentioned, these opportunistic behaviors were considered to be triggered by other hidden factors as

well. Among these, cost concern or other financial constraints were the most frequently emphasized. Moreover, there was the commercial greed and unfair competition (e.g. unfair competitive pricing) associated with cost concerns of supply chain members.

'*cows are slaughtered, rather than used for producing milk; just because meat is more expensive and profitable than milk*'.

Furthermore, issues such as increases in electricity prices lead to problems in cold logistics problems, because electricity consumption or fuel consumption concerns or increase in feed prices as well as increase in live-stock growth costs create cost minimization concerns in suppliers, which caused them to make opportunistic moves (e.g. concentrated, unnatural or water-mass feed).

'*coolers of vehicles are disabled or unplugged during distribution for electricity consumption*'

On the other hand, it has been argued that some supply chain members create false perception on products (e.g. on the origins of products, freshness of the products, or selling imported products as local and fresh), which is a type of fraud on the perception of consumers regarding the products marketed. Of course, vitality of supply of food products as a strong reason allowed for the opportunistic behaviors of the members.

'*food products are the priorities for consumers' vital necessities and has essentially to be consumed by any consumer, even with the one having a very limited budget*'

Therefore, *opportunism risk factors* were defined as the selfish or self-interest acts or approaches of supply chain partners (Williamson, 1975), which damages or harms other members of supply chains.

5.1.1.10. Labor Risk Factor

Labor risks, also mentioned in the literature as employee risks, are neglected in the literature, and deserve major attention, as being a very important driver for other risks (Sydow and Frenkel, 2013). Employee-related risks could either be about the tasks not performed as required, (not fully completed, inadequately completed, late completed…etc.) or performed in a more costly manner, with high indirect labor expenses, or could concern a conflict or non-compliance to rules, laws and regulations (Rosenberg, Perloff and Pradhan, 1994). Besides, it might also relate to labor resistance (Tsai, Liao and Han, 2008) or job change or transfer (Martinich, 2005). Thus, it is important that the "variance between actual and expected performance returns on an employee" (Datta, 2012:485) should be managed and reduced (Bitsch and Harsh, 2004).

In this research, employee related risk factors were also frequently mentioned. Issues such as the unavailability of qualified labor, incapability of labor (driver's intervention capability or technological equipment usage capability), poor psychology of labor, demotivated labor, reluctance of labor, short-term orientated labor, unconsciousness of labor, hygiene of labor, innovativeness of labor, adaptability of labor, licenses of labor, adequacy of labor qualifications, were all discussed as being critical triggers for risks in supply chains, which might lead to labor errors in critical processes, and result in serious health issues. Therefore, careful management of labor risk factors was emphasized. On the other hand, other soft issues, such as loyalty or job satisfaction of labor were argued to be very important in terms of avoiding risks in all processes, and therefore, high labor turnover rate (especially labor transfer to competitors or other companies) was considered to be a negative indicator.

Therefore, in this research, the risk factors which arise from or are associated with labor activities were identified as *labor risk factors*.

5.1.1.11. Legality Risk Factor

Legal risk is widely addressed in the literature (Zoellick and Frank, 2005; Handfield and McCormack, 2007; Belzer and Swan, 2011; Szymczak, 2013; Reynolds-Allie, Fields and Rainey, 2013), and is mostly associated with any risk related to law (Shi and Ruan, 2011). Illegality introduces an immoral situation (Belzer and Swan, 2011), and addresses closely all relevant risks in general (Zoellick and Frank, 2005). Thus, legal risk basically refers to non-compliance to legal requirements related to contracts, rules, regulations and laws, or the uncertainty related to legal actions (Handfield and McCormack, 2007; Reynolds-Allie, Fields and Rainey, 2013; Szymczak, 2013), as well as the non-existence of legal regulations and policies (Dimou, Chen and Archer, 2003).

In this research, non-compliance with legal requirements was discussed in several cases. Of course, lack of control (especially on illicit products), unlimited or uncontrolled authorization given to some members, lack of legal obligations on some particular cases (e.g. sustainability issues) were all considered to be the main triggers of legality-related risk factors. As a result, non-invoiced sales, issuance of unfair invoices, sales of unpackaged products (unlabeled live-stock, ambiguous live-stock identities, shipment waybill, live-stock welfare), problems in fit into current legislation, illegal disposal of products, market legalization problems were primarily considered to arise from non-compliance to legal requirements, or non-existence of legal regulations and policies.

Therefore, any risk factor which relates to non-compliance to legal requirements (Handfield and McCormack, 2007; Reynolds-Allie, Fields and Rainey, 2013; Szymczak, 2013), or the non-existence of legal regulations and policies (Dimou, Chen and Archer, 2003), was referred as *legality risk factor* in this research.

5.1.1.12. Health and Safety Risk Factor

Health is not only about the maintenance of physical welfare, but also related to mental and social welfare (as stated by the World Health Organization), and safety is a necessary condition for health (Papadopoulos et al., 2010). Health and safety is

an important area that deserves appropriate risk assessment related to every risk that threatens any individual, whether a worker or public (Starr and Whipple, 1984; Belcher, 2002; Walls et al., 2004; Papadopoulos et al., 2010). Therefore, this research considers occupational as well as public or human health and safety issues (Papadopoulos et al., 2010). Workers' hygiene, hazardous substances to health, vehicle and machineries threatening the health and safety are all considered within the scope of health and safety risk (Soon and Baines, 2012). Besides, these issues should be regulated (Walls et al., 2004), not only within the company limits, but also enlarged to related shareholders as well (Belcher, 2002).

Respondents frequently mentioned issues that threaten health and safety of all individuals involved in food supply chains (e.g. employees as well as public in general). Of course, the perishability of products was addressed as a major cause of health and safety risk factors. However, almost every respondent highlighted other factors, such as affordability or difference in income levels of consumers, lifestyles motivating bad consumption habits (also change in consumption habits), employee ethics as well as hygiene related problems (e.g. non-hygiene of equipment, non-hygiene of facilities, non-hygiene of vehicles, non-hygiene of raw materials, non-hygiene of packaging material or use of unhealthy packaging material, unavailability of necessary equipment for hygiene and physical dust in facilities) or other logistics processes such as operations. Moreover, other issues that might directly result from logistics operations could be considered to cause health and safety risk factors, such as accidents during logistics processes, unavailability of information in logistics processes, slow circulation of inventory, acceptance of a cold-chain broken product returns from the consumer, problems in production process, re-cooling of products in various logistics processes, R&D failure (e.g. in packaging) or incomplete cleaning of hygienic materials (esp. equipment, facilities, vehicles). On the other hand, unavailability of necessary or appropriate equipment was also mentioned as being important in terms of health and safety risk factors. Respondents also frequently mentioned microbiological hazards (e.g. bacteria growth) or growth and existence of pest in facilities, as well as in kitchens, which might have occurred due to hygiene issues or due to cold issues, as well as insidious diseases (e.g. live-stock disease), as being important drivers of health and safety issues. Besides, cross contamination was

addressed almost in every discussion related to health and safety risk factors (e.g. due to milk purchased from different suppliers are carried together in a single vehicle, dry cooling versus aqueous cooling, hygiene problems, storage conditions, shipment consolidation, end consumer kitchen process, inappropriate packaging materials, diseased meat carried in the same truck). Besides, chemical hazards or other additives, as well as other physical hazards in a product were highlighted, among other causes (e.g. agricultural chemicals, and medicines, antibiotic).

'*Chicken all are medicined*'
'*There are additive products in milk*'

Health and safety risk factors were importantly mentioned in terms of the environmental and social dimensions of sustainability.

'*Food health and safety threaten human health as a consequence*'

Negligence of social sustainability efforts for public health, negligence of employee welfare, low nutrition value of food products, and pollution were some examples in this scope.

Therefore, in this research, any factor threatening the health and safety of any individual, including employees and the public, was referred as *health and safety risk factors*.

5.1.1.13. Information Risk Factor

Information is a critical asset to every organization, which is, on one hand, required to be available to all who need it, but confidential who can misuse it on the other (Tarantino, 2008; Tsai et al., 2012). Besides, the integrity of information is necessarily important to ensure its accuracy. Information risk can be defined as any external or internal threat to the availability, confidentiality and integrity of the organization's information assets, such risk can be wide-ranging, complex and costly

(Tarantino, 2008). It also covers the inability to share information while making it complete, available, consistent, visible, accurate, and secure across the whole supply chain partners (Faisal, Banwet and Shankar, 2007; Lin and Zhou, 2011; Tsai et al., 2012). Information risks hold interest in the literature, and should also be managed in supply chains considering their remarkable impact on businesses (Faisal, Banwet and Shankar, 2006; Faisal, Banwet and Shankar, 2007; Tarantino, 2008; Lin and Zhou, 2011), but still deserves more specific attention in supply chain risk framework (Tang and Musa, 2011). Information risks potentially include information security, information distortion, information system breakdown or intellectual property rights risk, forecasting, information technology outsourcing risks (Faisal, Banwet and Shankar, 2006; Faisal, Banwet and Shankar, 2007). Surana et al. (2005) emphasize the importance of accurate and timely dynamic exchange of information as being the key to successful integration of complex network structure of supply chains.

In this research, respondents mentioned risk factors related to lack of information (e.g. on product labels, demand, temperature variations, quality condition by supply chain members), inconsistency of information, insufficient information (e.g. on storage conditions of products, product labels, information regarding packaging, shelf life, identity of the producer, storage conditions, differing shelf life values depending on the storage conditions), lack of internal and external communication, non-record of data information, or poor format of information (e.g. on packaging, format of the information on packaging to take the attention of the consumer), all of which might lead to coordination problems, complaint mismanagement, lack of awareness on problematic issues, poor communication with consumers (e.g. on nutrition value of products, storage conditions), inaccurate forecasting, inaccurate planning (e.g. in transportation capacity), poor inventory management, poor order management, communication problems with consumers, and information sharing or information integration problems (e.g. for consumers, information on regulative changes in food industry). This inaccurate or insufficient information was considered to create a lack of awareness, knowledge and consciousness, and thus leading to serious consequences (e.g. by cross contamination).

Therefore, in this research, any risk factor that might prevent the dissemination of complete, available, consistent, visible, accurate and secure information across the whole supply chain partners (Faisal, Banwet and Shankar, 2007; Lin and Zhou, 2011; Tsai et al., 2012) was referred as *information risk factors*.

5.1.1.14. Quality Risk Factor

Quality is highly related with satisfaction, which requires absence of defects and excellence (Shewfelt, 1999). Quality risk refers to the failure of the properties of a product, service, process or system to comply with the desired level of requirements, and is mentioned as a critical risk to be managed in the literature for supply chains of different businesses in various industries (Manuj and Mentzer, 2008; Roth et al., 2008; Gray, Roth and Leiblein, 2011; Li and Zhou, 2011; Tse et al., 2011). The objective is zero defects at the outcome, and any failure in reaching to this aim addresses a risk of quality.

In this research, quality risk factors were mentioned frequently from several aspects. Among the issues considered to cause hygiene problems and poor product quality were, in particular, negligence of product-specific sensitivities, invalidity of certifications, existence of non-certified players in the market, non-packaged products, negligence of raw material risk grouping in product development, non-qualified feed processing, use of non-qualified live-stock, negligence of live-stock welfare, use of non-qualified raw material, false stowage in containers and trucks, false stowage in stores, non-reliability of product content analysis, negligence of shelf life constraints of fresh stock, negligence of the impact of live-stock welfare on shelf life, negligence of shelf life dependence on hygiene, non-standardization of processes through automation, non-standardized quality of products, temperature variations in products, non-standardized temperature for cooling through automation, variations in cold logistics process temperatures (especially in air transportation), humidity in products (e.g. by pre-cooling of containers) or condensation in products. Besides, low nutrition valued products, and misconceptions on product quality were also explained to be caused by such factors.

Therefore, in this research, the failure to comply with the desired level of expectations on a product or a service (Manuj and Mentzer, 2008; Roth et al., 2008; Gray, Roth and Leiblein, 2011; Li and Zhou, 2011; Tse et al., 2011) was referred as *quality risk factors*.

5.1.1.15. Resource Risk Factor

Resource risk is the potential risk of not having (not being able to acquire or spare) the resources necessary to follow or adopt a strategy. It might even be a lack of or incapability related to a resource, such as technology, capital, labor, material, equipment, facility-specific requirements (Ghoshal, 1987; Chatterjee and Ramesh, 1999; Savci and Kayis, 2006; Manuj and Menzer, 2008), or a non-functionality as well as failure of an owned resource (Larson and Kusiak, 1996), or any uncertainty related to the resources, such as price, availability (Chatterjee and Ramesh, 1999).

In this research, respondents discussed issues related to resources which trigger problems at several areas. The respondents mentioned risks in this area due to the following resource-related factors: Inappropriateness of equipment, vehicles or facilities (e.g. facility qualifications, especially of manufacturers, standardization, hygiene, quality, isolation, fixture, air tight, undistinguished operational and storage areas, heat leakage), non-availability of equipment (e.g. faucet; sanitizer equipment), raw materials or supply, non-availability of laboratory analysis at critical operational nodes (chemical-biological analysis at different nodes).

'*wood cases should not be used to store fish, plastic should be preferred instead*'

On the other hand, there are some issues mentioned, which results in hygiene problems, quality problems, isolation problems or cold logistics operations, and were related with resource related factors, such as technological or equipment failure (e.g. machine failure, production interruption, pump failure, transportation problems, cooler failure, inaccuracy of automatic reject checks). Negligence of repair and maintenance on, e.g., equipment, facility or vehicles (especially for cold storage), were also included among the causes of such problems, as well as of health and

safety problems, standardization problems, structural problems or service failure. Besides, non-renewal of vehicles or equipment was also raised as causes of resource related risk factors.

On the other hand, respondents associated resource related risk factors with sustainability. This was to emphasize the role of resources that might consume unnecessary levels of natural resources, while performing today's operations. Unavailability of appropriate equipment for green management, non-automated equipment for natural resource saving, use of natural resource consuming equipment or non-availability of green equipment and poor green performance of operations have been considered responsible for scarcity in natural resources or sustainability (especially, green) management concerns (e.g. equipment which use excessive amounts of water, energy...etc). There were also the arguments addressing to the unaffordability of consumers for sustainable products (lack of monetary resources) and difference in income levels of consumers for sustainable consumption, resulting in unsustainable consumption habits. Besides, respondents also mentioned the cost concern for sustainability investments, service trends consuming unnecessary levels of natural resources (service trends consuming water/energy), unsustainable operations (e.g. farming) which lead to resource related risk factors. On the other hand, vitality of supply was highlighted as a threat for social sustainability as well.

Therefore, any risk factor which relates to the lack of, incapability, non-functionality, uncertainty or failure of, either a current or a future resource, (Ghoshal, 1987; Larson and Kusiak, 1996; Chatterjee and Ramesh, 1999; Savci and Kayis, 2006; Manuj and Menzer, 2008), was referred to as *resource risk factor* in this research.

5.1.1.16. Traceability Risk Factor

Traceability, either chain-wide or in internal scope, means the ability to follow, track and trace every step of a product, an activity or a process necessitating the transparency of information between related parties (Sarig, 2003; Schwägele, 2005; Olsson and Skjöldebrand, 2008; Van Rijswijk and Frewer, 2008;). Transparency requires a high involvement of supply chain partners into the

information flow through different business processes (Carter and Rogers, 2008). As mentioned by Beulens et al. (2005:482), transparency of a supply chain network is "the extent to which, all the network's stakeholders have a shared understanding of, and access to, product and process related information that they request, without loss, noise, delay and distortion". Traceability incorporating the supply chain perspective is not widely studied in the literature (Olsson and Skjöldebrand, 2008). The traceability in terms of risk mostly focuses on how accurate traceability can reduce the risk exposure (Bevilacqua, Ciarapica and Giacchetta, 2009) Thus, in the literature, traceability is viewed as a risk management tool, also ensuring quality and safety (Charlier and Valceschini, 2008; Bevilacqua, Ciarapica and Giacchetta, 2009; Cao et al., 2011), but not identified as a distinctive risk item as traceability risk to mention any potential failure in establishing traceability throughout the chain.

In the research, ambiguity of products, unpackaged products, non-branded or unlabeled products (e.g. in fish markets) as well as ambiguity in live-stock growth process, ambiguity in live-stock identities, non-traceability of logistics process or product temperatures, untracking of shelf life records combined with negligence of R&D efforts for temperature traceability or in detecting additives, negligence of follow up of logistics process by subcontractors or by agencies, negligence of sampling, negligence of temperature verification and validation in cold logistics processes (verification of technological records, validation of results and analysis, especially in cold and heat treatment processes, deviations to be reviewed), and non-existence of technological traceability were considered by the respondents as causes of poor supply chain traceability, non-traceability of batches, poor control management, unavailability of internal or supply chain-wide transparency as well as problems in recall management. These traceability related issues, in turn, were mentioned as leading to risks in supply chain logistics operations.

Therefore, in this research, *traceability risk factors* were defined as any risk factor which might have been caused due to any problems in following, tracking and tracing the supply chain logistics activities of a product, an activity or a process, at which a transparent information sharing among related parties cannot be provided (Sarig, 2003; Schwägele, 2005; Olsson and Skjöldebrand, 2008; Van Rijswijk and Frewer, 2008).

5.1.1.17. Reputation Risk Factor

From a corporate perspective, reputation is all about the perception or socially constructed impression of a positive or a negative feeling of related stakeholders towards a corporate name or a corporate identity. Therefore, risks related to reputation are not represented by a physical failure, instead, it is the failure in building this true perception or confidence in the eyes of the stakeholders and are not physical in general (Larkin, 2002; Harland, Brenchley and Walker, 2003). This loss of subjective assessment in the reliability and trustworthiness of the corporate identity or brands cause reputation risks, which could result in catastrophic consequences (Bebbington, Larrinaga and Moneva, 2008), due to loss of market value of a company. In this context, the communication with all relevant stakeholders is critically important for a company to mitigate this risk of reputation loss (Frigo and Ramaswamy, 2009).

Corporate social reporting is an element of reputation risk management. It is widely accepted that corporate social reporting efforts, both voluntary and mandatory, are a part of the reputation risk management strategies of a company, especially in developed countries. Reputation is the intangible assets of companies which enhance their reliability and trustworthiness. Social, environmental, ethical responsibility is one element which shows the reputation of a company (Bebbington, Larrinaga and Moneva, 2008).

In this research, respondents mentioned problems related to false perception, bad experience, unconsciousness, unawareness, conventionalism or habits which result in inappropriate bias towards supply chain members, consumer distrust towards supply chain members, consumer distrust towards brands, as well as loss of reputation and trust. Here, it is important to note that, although mentioned by almost every consumer interviewed, this risk factor was only mentioned by six supply chain members, four of which were working in restaurants or retailers (with additionally one distribution warehouse and one logistics service provider).

Therefore, in this research, any risk factor leading to a problem in a failure or in building true perception or confidence in the eyes of the stakeholders (Larkin, 2002; Harland, Brenchley and Walker, 2003), were referred as *reputation risk factors*.

5.1.1.18. Seasonality Risk Factor

Despite seasonality as a risk is mostly referred in terms of its financial impacts (Kerkhof, 2005), it is also a risk for other areas of businesses, such as sales (Metters, 1997), marketing in international scope (Zorkóciová and Jamborová, 2013) or production also when coping with environmental sustainability problems (Kopke, Young and Kingwell, 2008; Keno, 2012). Seasonality risk, in simplest terms, can be defined as "the risk resulting from a product that experiences seasonal demand" (Schwartz and Chandler, 2012:398). It might either be a weather season, holiday season, peak sales season, a consumer demand season, or a new model launch season which depends on the industry, product, company or the environment of the company in general. Thus, seasonality is an important risk factor to be considered in terms of any decision given by the business units when planning, forecasting, deciding or reviewing business inputs (Metters, 1997; Schwartz and Chandler, 2012), e.g. the financials, inventory, resources or personnel. Besides, food cold chains are highly affected by temperature variations resulting from climate changes (James and James, 2010).

In the research, due to such seasonality effects, the problems related to capacity constraints, demand fluctuations, inefficient products, challenges in live-stock growth process or challenges in cold logistics operations were mentioned by the respondents. Besides, it has been explained that temperature variations due to weather seasons result in temperature variations or control problems in cold logistics operations.

Therefore, any risk factor which was associated with seasonal variations in conditions was referred as *seasonality risk factors*.

5.1.1.19. Stakeholder Risk Factor

Stakeholders, both the internal ones as employees, managers or board members, or external ones as customers, shareholders, local community and regulatory authorities, constitute a network of relationships, and are associated with different dimensions of risks in businesses. They concern for different interests and

perspectives (Rego, Billett and Morgan, 2009). Thus, predicting as well as managing those risks needs special attention, as it covers various dynamics (Yang and Zou, 2014).

In this research, respondents discussed several risk factors associated with other stakeholders. Some examples outlined from those discussions involve dominance of some stakeholders (e.g. forcing to self-interest in agreement conditions), pressure by stakeholders (especially by the focal company), pressure by multiple stakeholders searching for different interests, lack of affordable or qualified suppliers, availability of suppliers with liquidation problems, incapability or unaffordability of stakeholders (especially upward chain members e.g. SME's, small sized food markets, grocery stores, subcontractors, dealers or other retailers), lack of institutionalized suppliers and lack of alternative suppliers. Besides, supplier inertia, monopoly of supply, unavailability of alternative suppliers, non-competitiveness in supply market, dependence on a single supplier, dominance of a single supplier or high bargaining power of supplier were considered to be critically important factors causing risk at all levels. On the other hand, other stakeholder related issues, such as volition of contract conditions by stakeholders, stakeholders with high cost concern, negligence of win-win approach in supply chain relationships, building arms' length relationships rather than long term were also emphasized as important triggers for risks.

'*arms' length supply chains are riskier than long relationship or vertically integrated supply chains*'

Therefore, in this research, the risks that might have been caused by any stakeholder related issues were referred to as *stakeholder risk factor*.

5.1.1.20. Self-Focus Risk Factor

Self-focus represents the fact of excessive concern of oneself while ignoring others[3]. It is strongly evident that integration is critical to supply chain success

[3] http://psychologydictionary.org/self-focus/

(Zhang, Shi and Dai, 2008) and any decision that keeps supply chain away from integration will result in poor performance for all members. Especially, decentralization necessitated by global operations and self-focuses of supply chain members hinders optimal performances (Zhang, Shi and Dai, 2008). Besides, self-focus in businesses may bring overconfidence and poor strategic decisions provided by the ignorance of market dynamics or underestimation of any negativity that might arise from other supply chain partners or competitor activities (Moore, Oesch and Zietsma, 2007).

In supply chains, none of the actors are taking a holistic responsibility; rather they are acting on their own (Olsson and Skjöldebrand, 2008). This was also evident in multiple-case study research notes, which frequently mention self-focused control (track, trace, control, audit at individual supply chain nodes), self-focused inventory management, taking self-focus responsibility on logistics processes rather than full responsibility on all processes, self-expertise focus only (focus on individual expertise), self-focused sustainability efforts and practices, or self-focus sustainability audits and controls, as well as ambiguity in share of responsibility. This was explained to be resulting in problems in building an integrated supply chain perspective, collaboration among members, an integrated supply chain risk management system, integrated supply chain sustainability management system, supply chain responsibility integration and integrated supply chain inventory management system.

'*stock levels are determined by different members of supply chains based on different inventory management policies from an individualistic focus'*.
'*tracking is done at individual nodes, instead of an integrated tracking system*'
'*supply chain level control is necessary rather than controlling individual members only*'
'*supply chain is not controlled from an integrated perspective*'
'*end supply chain nodes (e.g. customers) are neglected*'
'*focus on only ones' own expertise is a barrier for an integrated supply chain perspective*'

This disintegrated perspective in supply chain logistics processes meant basically the negligence of other chain members (esp. the consumers), and triggered several other risk issues, such as shelf life expiration due to excess inventories, complaint mismanagement…etc.

Therefore, in this research, the lack of a holistic perspective in supply chain logistics operations was referred as *self-focus risk factor*.

5.1.1.21. Planning Risk Factor

Planning risk can be defined as "inability to maintain stable and consistent production planning and scheduling" (Lin and Zhou, 2011:178). When triggered by sudden changes, planning risk becomes a critical concern for supply chain partners. Although not common, planning risk is addressed in the literature as a distinctive risk item (Berenji and Anantharaman, 2011).

Planning was related with several risk aspects in the research. Problems such as demand planning, materials planning, distribution planning, capacity planning, shelf life planning, shipment route, trip frequency or transshipment planning, as well as product size planning, product addressing, order revisions and cancellations, were some discussions that address the planning related risk factors. Besides, inappropriate planning of facility, storage, or equipment, inappropriate construction of facility for green management or use of inappropriate construction of facility equipment for green management were explained by planning errors. Such issues were thought to result in inefficiency of logistics operations, cold logistics problems (e.g. several delivery nodes) and even mismanagement of waste, hygiene problems and scarcity in natural resources (by natural resource consuming facilities and equipment).

Therefore, in this research, *planning risk factor* was defined from a broader perspective, such as the problems that were caused by the inability to plan supply chain and logistics related processes and operations.

5.1.1.22. Structural Risk Factor

Structural risk is becoming a common concern for supply chain partners due to extended networks moving around the globe (Klimov and Merkuryev, 2008; Kumar, Ozdamar and Ning Zhang, 2008; Bardhan, Jaffee and Kroll, 2013). It is important that the offshoring supply chain partners should recognize the internal challenges related to structural issues due to misalignment of organizational structures or relational issues of different partners raising also operational risks (Kumar, Ozdamar and Ning Zhang, 2008; Bardhan, Jaffee and Kroll, 2013), or complexity and uncertainty in business environment surrounding the network structures of supply chains (Klimov and Merkuryev, 2008).

In the research, at macro level, complex network design, long supply chains, long channels of distribution, long sales channels with various levels of intermediaries, high levels of outsourcing, non-proximity of suppliers (e.g. live-stock growth facilities) to consumer markets, complexity of distribution network; or at micro level, company infrastructure deficiencies, location infrastructure deficiencies, city infrastructure deficiencies, poor store design leading to long shopping time, inadequacy of in-store space in which necessary equipment for cold storage and hygiene cannot be stored, were all associated with structural risk factors in the discussions, which resulted in hygiene problems, cold logistics problems, control problems, distribution problems, and other inefficiencies.

‘*long supply chains are riskier, especially if they are not vertically integrated*’
‘*special design to place cold chain products is necessarily important*’

Therefore, the problems that were caused by internal or external structures of supply chains and supply chain members are referred as *structural risk factors* in this research.

5.1.1.23. Perception Risk Factors

Perception risk is an issue of concern when a product does not satisfy the desire or needs of individuals, and represents the failure in delivery of the expected value (Tang et al., 2011). Thus, it is basically about negativity in terms of reputation, sense of security, confidence, belief and image in the eyes of individuals, triggered by the failure in procedures, communication and explanations (Chang and Liu, 2011; Chen, 2011). It necessitates setting the appropriate commitment, and alignment to this commitment to ensure the safety and comfort of the individuals.

In the research, respondents discussed fatalism, cynicism, unconsciousness, unawareness, culture, habits, and conventionalism as being the critical factors which created a negative perception or distrust among the consumers or the employees. Besides, it has been argued that false perception was created at the consumers, e.g. by pricing strategies or by discounts.

'*Consumers have the perception that food growth process is maleficiant*'
'*Consumers consider organic products as natural products or food grown up in villages are organic*'
'*Consumers perceive that expensives are organic*'
'*Consumers perceive that dicsounts are for shelf life expired or low quality products*'

On the other hand, supply chain members have not developed a consumer point of view which resulted in a lack of understanding on consumer requirements, and thus allowed for a path for perception fraud. Conversely, some supply chain members (e.g. agencies) stayed closer to customers, and perceived themselves as customers. This created an imbalance in relationships due to the fact that agencies vindicated the rights of customers only. Besides, there was the factor of false risk perception of employees, managers or the consumers that triggered other risks.

Therefore, anything that truly or falsely affected the perception of individuals in supply chains, which resulted in the failure in delivery of the expected value, was referred to as *perception risk factors* in this research.

5.1.2. Mitigation Strategies Outlined by the Multiple-Case Study

The discussions during the multiple-case study interviews also outlined several mitigation strategies offered by the respondents. The respondents highlighted that, in order to manage complacency risk factors, the mitigation strategies would be to share information with people, especially on the consequences, forming departments, which only deals with such aspects, or focus on dissuasive regulations for avoiding complacency.

Besides, they proposed some mitigation strategies to avoid capability risk factors, such as adopting horizontal integration strategies, working with selected suppliers instead of many multiples, training logistics partners, planning for frequent controls, investing on specialized equipment, vehicles (sealed trucks) or other construction materials (isolated doors, walls), investing on technological tracking systems or other technological advancements (e.g. use quick freeze, automatic milk makers, use sensor, focused cooling), adopting proactive risk management procedures (e.g. probability and impact analysis, risk mapping, risk and hazard analysis) and formalizing insurance policies.

For mitigating control risk, respondents recommended integrating vertically, supplying critical equipment, ensuring control by each personnel (e.g. sales employees controlling each sales node), providing financial support, and checking for legal reports or certifications at each supply chain member.

Of course, periodic controls, industry-specific regulations, government incentives and support, technological traceability and tracking systems (especially through technological devices, e.g. Global Positioning System (GPS) given to all fishermen, tracking by satellite control systems) and brand audits, governmental audits by unexpected visits, as well as measurement of energy and water consumption (e.g. follow monthly electricity consumption), managing lost property issues (e.g. by destroying the product or quick cooking or by low cost sales), making non-return agreements by upward chain members (e.g. by offering discounts), training or incurring electric costs of weak supply chain members were argued to be beneficial to ensure control at all stages.

The mitigation strategies in order to avoid dependence risk factors addressed decisions for whether to grow or buy live stock, or ensure safety and security through technological advancements. Of course, the need to follow external changes and ensuring quick adaptation to market changes, new trends, rules or regulations were also mentioned in the discussions.

For consciousness risk factors, the mitigations strategies discussed mostly addressed the importance of training, even from the cradle. Furthermore, the following were all highlighted as being important: cooperation with universities, trained and expert employees, veterinary support, trainings for all levels of employees, open education centers for training employees, quality technicians at critical processes (e.g. accompanying the harvesting process, checks, measures the freezing period, temperature, to implement FIFO strategy), temperature checks, cooling time (+4 degree, max +6 degree 6 hours after harvesting), implementing proper packaging methodologies, packaging quality, trainings of supply chain members on (proper) packaging, specific packaging materials and methods based on transportation mode, special packaging equipment, on-time, use of modernized air conditioning equipment.

There were also some mitigation strategies offered by the respondents for governance risk factors such as supply chain wide governance of conflicting concerns, applying sanctions and incentives (e.g. tax incentives, monetary incentives to support farmers or legal production), grading and reusing unsold fish as feed, management of waste, working with certified disposal companies, working with qualified suppliers instead of only low cost ones, building flexible supply chains to improve flexibility of supply chains, improving actions for protecting the environment (e.g. friend of sea certificate, cribs located far away from the coast despite cost, growing plants to clean the sea), environmental performance management (e.g. measure the pollution), improve security (e.g. camera systems to control pollution/feeding at sea), using technological advancements (automatic feeding machines which stops feeding), and continuous follow up and analysis (e.g. by central tests).

To avoid inertia risk factors, the mitigation strategies offered by the respondents mostly highlighted the need for training. The mitigation strategies

highlighted for opportunism risk factor was mostly address to the adaptation of technological advancements, improving controls throughout the chain, product-type focused planning, strong collaboration or vertical integration, win-win approach (applying agreements which benefits all parties), and improving consumer attention.

Mitigation strategies offered by the respondents to avoid labor risk factors mostly addressed the need for licensed employees, and the efforts need to be made to improve consciousness as well as satisfaction of labor. Legality risk factor mitigation strategies called for industry-specific regulations and improved controls on related processes. Besides, the importance of governmental support and incentives, improved tracking with technological devices (provide GPS to all fishermen, track by satellite control systems), more frequent governmental audits as well as brand audits were emphasized.

The respondents mentioned several mitigation strategies related to health and safety risk factors, such as use of a signaling system powered by solar energy, radar reflectors, mark fishing nets on international maps, establishing control mechanisms to analyze, test and differentiate additives (e.g. antibiotics) in food products, improving governmental control, improving controls at supplier, making quality tests, ensuring correct stowage in containers-trucks, implement species health management, periodically make blood controls, not allowing enter, hygienic pools, hand-foot clearance, bonnet, follow up by camera system, ensuring equipment clearance, ensuring veterinary controls, measuring and following number of insects, not allowing any jewelry, hairclip...etc., using a camera system, using metal detectors, making x-ray controls, and improving hygiene controls.

The mitigation strategies especially addressed the regulatory support, improved coordination and technological advancements for avoiding information risk factors. Quality risk factors were proposed to be avoided by vertical integration (e.g. make/process your own feed), more frequent visual checks on live-stock, applying performance management or quality management systems were among mitigation strategies mentioned by the respondents.

The mitigation strategies recommend by the respondents to avoid resource risk factors mostly address improving periodic controls (e.g. employ electrician-technicians, keep a backup engine, use generator, periodic calibration), using

resource friendly equipment and improving qualifications (including hygiene) of equipment, vehicles and facilities (e.g. heat isolation in facilities, loading/unloading area, storage area). Of course, support of the focal company, and close coordination and communication between supply chain members were emphasized in fixing the problems related to resources.

For avoiding traceability risk factors, the mitigation strategies discussed address the need of the adaptation to technological advancements (e.g. data logger, technological devices, online follow up, sealed doors, GPS at all supply chain levels), and implementation of traceability and recall management systems. Building long-term relationships with stakeholders and backup alternative stakeholders were the two most discussed mitigation strategies for stakeholder risk factors.

The mitigation strategies to avoiding self-focus risk factors all addressed the need for developing an integrated supply chain perspective in all logistics processes. On the other hand, respondents mentioned mitigation strategies for ethics, reputation, seasonality, planning, structural and perception risk factors in minority with very similar comments of others. Here, legislations ensuring strict controls were recommended as the most important mitigation strategy.

When the mitigation strategies mentioned during the interviews were reviewed, it has been outlined that there are some mitigation strategies which were mentioned commonly for avoiding most of the risk factors. The most prominent ones were the strategies to be developed to improving awareness by training and education starting from the early ages for all individual supply chain members as well as the consumers, improving information sharing throughout the supply chains, improving technological capabilities, ensuring strict controls at almost every stage of logistics processes, improving integration throughout the supply chains, implement supplier performance management systems, and a focus on consumers and consumer side activities. These address to the risk mitigation strategies to be primarily considered for implementing to avoid several risk factors in food supply chains from a holistic perspective.

5.1.3. Grouping Supply Chain Risk Factors

Supply chin risk factors outlined by the multiple-case study were then grouped in five main categories based on the most dominant emphasis in the related discussions of each risk factor. The groupings were then validated by the three academicians (Berg, 2001; Creswell, 2007), who were the same reviewers of the multiple-case data. The five groups defined were, namely, behavioral, managerial, moral, competence and interconnectedness risk factors.

5.1.3.1. Behavioral Risk Factors

The review of the multiple-case study notes showed that some of the risk factors addressed behavioral aspects. That is, the fundamental causes of those risks collide with one another in terms of their behavioral impacts over individuals in supply chains (consumers, employees…etc.). It has been discussed that behaviors were triggered by culture, habits, fatalism, experiences, consciousness, knowledge, awareness or attention as well as by complacency, perception or reputation. Any negativity in terms of these aspects can affect the behaviors of individuals, (employees, consumers or other supply chain members), and result in serious consequences in terms of supply chains.

Therefore, *behavioral risk factors* are the factors which affect the behaviors of supply chain members, and lead to a risk in supply chain logistics activities. The respondents mentioned that complacency, consciousness, perception, employee and reputation risk factors were all potential causes that might trigger behavioral risk factors and might lead to a hazardous event. In complacency risk factors, there is the underestimation of risks negligence, inertia or passivity (Kämpf and Haley, 2011; Enyinda, Anaza and Hamouri, 2013), which result in complacent behaviors of employees, consumers or other supply chain members. Similarly, consciousness risk factors, although relating mostly to the inherence of the exception of awareness, reinforces the behavior and organizing power of individuals towards performing a task (Zaltman, 2000; Gustavsson, 2001). Besides, perception risk factors caused by the failure in delivery of the expected value requires for setting the appropriate

commitment and alignment for making individuals safe and comfortable (Chang and Liu, 2011; Chen, 2011; Tang et al., 2011) in order to ensure a desired level of behavior. Moreover, reputation risk factors, which are associated with building true perception or confidence in the eyes of the stakeholders (Larkin, 2002; Harland, Brenchley and Walker, 2003), in the end affect behavior (either a positive or a negative) towards a product, a process, an activity, an individual or a supply chain member. On the other hand, labor risk factors were directly associated with employee activities, and about the tasks not performed by the employees as required; thus, were considered within behavioral risk factors. Therefore, complacency, consciousness, perception, reputation and labor risk factors were grouped as behavioral risk factors.

5.1.3.2. Managerial Risk Factors

During the discussions with the respondents, some of the risk factors were explained to be associated with managerial aspects. That is, managerial issues were considered the main causes of the lack of control throughout the supply chains and supply chain logistics operations (Christopher and Lee, 2004; Albersmeier et al., 2009), the failures in governance (Von Kanel at al., 2010) either management or control, incapability and resistance of organizations to change (Fawcett and Magnan; 2001; Jüttner, Peck and Christopher, 2003), the lack of a holistic perspective in supply chains and supply chain logistics operations (Zhang, Shi and Dai, 2008), the inability to plan supply chain and logistics related processes and operations (Lin and Zhou, 2011), non-compliance to legal requirements (Handfield and McCormack, 2007; Reynolds-Allie, Fields and Rainey, 2013; Szymczak, 2013) as well as the lack of health and safety management systems in supply chains (Walls et al., 2004; Papadopoulos et al., 2010). These arguments addressed control, governance, legality, self-focus, planning, inertia and health and safety risk factors closely associated with managerial causes. This means that the managerial approach in supply chains would trigger as well as avoid those risk factors. Therefore, in this research managerial risk factors were identified to be representing control, governance, legality, self-focus, planning, inertia and health and safety risk factors.

5.1.3.3. Competence Risk Factors

The discussions on some of the risk factors were related to the level of competencies achieved by supply chains. The incapability that prevent a supply chain from failing to achieve a desired level of performance (Tanrıverdi and Ruefli, 2004; Ifandoudas and Chapman 2009), and the failure to comply the desired level of expectations on a product or a service (Roth et al., 2007; Manuj and Mentzer, 2008; Gray, Roth and Leiblein, 2011; Li and Zhou, 2011; Tse et al., 2011) were all argued to negatively affect the level of competency of supply chains. Besides, the availability, confidentiality, share and integrity of information throughout the supply chains (Faisal, Banwet, Shankar, 2007; Tarantino, 2008; Lin and Zhou, 2011; Tsai et al., 2012) was considered as one key competency to successful integration of complex network structure of supply chains. Moreover, the lack, incapability, non-functionality, uncertainty or failure of a related resource (Ghoshal, 1987; Larson and Kusiak, 1996; Chatterjee and Ramesh, 1999; Savci and Kayis, 2006; Manuj and Menzer, 2008) was argued as another risk factor which refers to a loss of competence. On the other hand, the inability to follow, track and trace supply chain logistics activities or processes (Sarig, 2003; Schwägele, 2005; Olsson and Skjöldebrand, 2008; Van Rijswijk and Frewer, 2008) threatens quality and safety (Charlier and Valceschini, 2008; Bevilacqua, Ciarapica and Giacchetta, 2009; Cao et al., 2011), thus threatening the competence. Therefore, capability, quality, resource, traceability and information risk factors were outlined to be colliding in terms of their fundamental effects on competences, and thus were grouped as competence risk factors.

5.1.3.4. Moral Risk Factors

Selfish or self-interest acts, or approaches of supply chain partners, and the violation of ethics or compliance for welfare of the public as well as of the organizations were discussed to be addressing a moral disorder. The self-interest act inherently addresses to lack of honesty and a problem of ethics, trust and commitment (Williamson, 1975; Carter and Easton, 2011). On the other hand, the

acts violating ethics or compliance means also a violation of morality, conduct, honesty, fairness, integrity, equity and legitimacy for welfare of public and organizations (Walker and Rowlinson, 2007). Therefore, in this research, opportunism and ethics risk factors were grouped as moral risk factors.

5.1.3.5. Interconnectedness Risk Factors

It has been outlined that, in supply chains, there is a strong interconnectedness towards various aspects. Larger forces that supply chains were affected by any failure or negativity at any (Hallikas et al., 2005; Wagner and Bode, 2006; Liao, Liao and Hutchinson, 2009; Tsai et al., 2012; Li et al., 2014), or more individualistic forces generated by stakeholders, which is in a search for satisfying different interests and perspectives or other dynamics (Rego, Billett and Morgan, 2009) were all considered as being the causes that create interconnectedness in supply chain logistics operations. It was also argued that, extended networks were also becoming the cause for risks in supply chains (Klimov and Merkuryev, 2008; Kumar, Ozdamar and Ning Zhang, 2008; Bardhan, Jaffee and Kroll, 2013), which referred to another trigger related to interconnectedness. When considered from a more focused perspective, supply chain logistics operations were also considered to be interconnected to seasonality factors (Schwartz and Chandler, 2012). When considered from this perspective, it has been outlined that, dependence, structural, stakeholder and seasonality risk factors addressed to a common cause related to interconnectedness, and thus were grouped as interconnectedness risk factor.

5.1.4. Review of Supply Chain Risk Factors by Manifest Content Analysis

In this research, the risk factors were identified and entitled based on the common focus of emphasis at each discussion. However, it was also necessary to verify the titles of each risk factor by reviewing whether or not risk factors defined in this multiple case study exist in the related literature, and if so, with which frequency. Therefore, the articles published on *web of knowledge* database were downloaded

with *risk* in title and *supply chain* or *logistics* in topic. The language was limited to English, and the document type was restricted to article only. In total, 488 articles could be accessed, and twenty three risk factors, as well as their related risk factor groups, were searched by NVivo software.

The results indicated that *competence risk* and *behavioral risk* factors were distinctively defined with those coding titles among the articles, whereas *managerial*, *moral* and *interconnectedness risk factors* were not coded directly as such (Table 12). Despite this, risk issues related to *moral*, *interconnectedness* and *managerial* issues were referred for 6, 4 and 71 times respectively. Among all, especially, *managerial* related issues were discussed while addressing risk factors in supply chains and logistics activities, which is followed by *behavioral* and *competence* related risk factors.

Table 12: Results of Manifest Content Analysis for Risk Factor Groups

Risk Factor Group	Frequency of Risk Factor Code	Frequency of Discussions on Risk Factor
Managerial Risk Factors	0	71
Behavioral Risk Factors	2	32
Competence Risk Factors	1	18
Moral Risk Factors	0	6
Interconnectedness Risk Factors	0	4

The results of twenty-three risk factors were also presented in Table 13.

Table 13: Results of Manifest Content Analysis for Risk Factors

Risk Factor	Frequency of Risk Factor Code	Frequency of Discussions on Risk Factor
Planning Risk Factor	4	234
Information Risk Factor	10	222
Safety Risk Factor	9	147
Quality Risk Factor	12	138
Dependence Risk Factor	0	73
Control Risk Factor	6	72
Health Risk Factor	2	42
Resource Risk Factor	0	26
Structural Risk Factor	0	24
Perception Risk Factor	4	22
Governance Risk Factor	0	19
Seasonality Risk Factor	0	14
Traceability Risk Factor	0	13
Labor Risk Factor	1	12
Capability Risk Factor	0	9
Legal Risk Factor	1	8
Reputation Risk Factor	1	7
Stakeholder Risk Factor	0	7
Consciousness Risk Factor	0	1
Self-Focus Risk Factor	0	1
Ethics Risk Factor	0	1
Opportunism Risk Factor	0	1
Complacency Risk Factor	0	0
Inertia Risk Factor	0	0

In *competence risk factors*, which were found to be coded by 1 time already, *information risk factor* was highly coded 10 times, whereas the issues were related with *information* in those risk related articles 222 times. Also, *quality risk factor* was coded by 12 times among those articles and the issues related to *quality*, while explaining risk was referred for 138 times. Although the risk factors were not directly coded and referred as *resource*, *traceability* or *capability risk factors*, the risk issues were explained by relating to *resource*, *traceability* and *capability* for 26, 13 and 9 times respectively. This shows that risk issues were mostly associated with *information* and *quality* related tasks.

Besides, *behavioral risk factors* were also coded 2 times. Among the risk factors associated with this group, *perception risk factor* was coded 4 times, and *perception* related issues were referred to 22 times while explaining risk. *Labor risk*

and *reputation risk factors* were also coded among the articles, and *labor* and *reputation* related risk issues were referred for 12 and 8 times respectively. Although *consciousness* and *complacency risk factors* were coded directly, *consciousness* related risk issues were referred to only 1 time, whereas *complacency*, none.

Although *managerial risk factors* were not defined directly with this coding, *managerial* related issues are mentioned for 71 times. Moreover, *health and safety risk factor* of this group was not directly referred as it is, however *health risk* and *safety risk* factors were coded distinctively 2 and 9 times, respectively. Besides, *health* related risk issues were referred 42 times, while *safety* related 147 times. On the other hand, *control risk* and *planning risk factors* were coded 6 and 4 times respectively, while *control* and *planning* issues were related to risk events 72 and 234 times. *Legal risk factor* was defined as a distinctive code among those articles, and risk issues were related with legal factors 8 times. Although *governance risk factor* was not referred as a distinctive code, *governance* issues were referred while explaining risk 19 times. On the other hand, *self-focus risk factor* was not coded as such, however there was 1 *self-focus* issue addressed among the articles. *Inertia risk factor* was not referred with any similar code or reference; however, issues related to continuous improvement, which oppose to the factors related with *inertia*, were referred 5 times.

In *moral risk factors*, although *moral* issues, including *ethics* and *opportunism* related factors, were referred 6, 1 and 1 times respectively, *moral risk*, *ethics risk* or *opportunism risk factors* were not coded as such.

Similarly, *interconnectedness risk factor* was not coded as a risk factor directly, however there were 4 issues discussed related to *interconnectedness*. *Dependence*, *structural*, *seasonality* and *stakeholder risk factors* were not coded directly as such, however there were related issues which addressed to those risk factors by 73, 24, 14 and 7 times respectively.

The results indicated that, almost all of the risk factors, though not directly coded as such, were a part of risk related discussions among the articles. Especially, planning, information, safety, quality, dependence and control related risk factors were highly mentioned in the articles, whereas health, resource, structural, perception, governance, seasonality, traceability, labor, capability, legal, reputation and

stakeholder related issues were relatively much lower. On the other hand, were some risk factors mentioned by a minority, such as consciousness, self-focus, ethics, opportunism; or not mentioned at all, namely complacency and inertia.

When the groups of risk factors were compared, the emphases on managerial and competence risk factor groups were identified to be remarkably higher, with 594 and 426 times occurrence of repetition of related words, respectively. These were followed by interconnectedness, behavioral and moral risk factor groups with 122, 74 and 8 times repetition (Table 14).

Table 14: The Review of the Frequency of Risk Factors and their Groups

Risk Factor and Groups of Risk Factors	Frequency of Risk Factor Code	Frequency of Discussions on Risk Factor
Managerial Risk Factors	0	71
Planning Risk Factor	4	234
Safety Risk Factor	2	147
Control Risk Factor	9	72
Health Risk Factor	6	42
Governance Risk Factor	0	19
Legal Risk Factor	1	8
Self-Focus Risk Factor	0	1
Inertia Risk Factor	0	0
TOTAL		**594**
Competence Risk Factors	1	18
Information Risk Factor	10	222
Quality Risk Factor	12	138
Resource Risk Factor	0	26
Traceability Risk Factor	0	13
Capability Risk Factor	0	9
TOTAL		**426**
Interconnectedness Risk Factors	0	4
Dependence Risk Factor	0	73
Structural Risk Factor	0	24
Seasonality Risk Factor	0	14
Stakeholder Risk Factor	0	7
TOTAL		**122**
Behavioral Risk Factors	2	32
Perception Risk Factor	4	22
Labor Risk Factor	1	12
Reputation Risk Factor	1	7
Consciousness Risk Factor	0	1
Complacency Risk Factor	0	0
TOTAL		**74**
Moral Risk Factors	0	6
Ethics Risk Factor	0	1
Opportunism Risk Factor	0	1
TOTAL		**8**

The results indicate that managerial and competence related issues, especially planning, information, safety, quality, dependence and control related issues, were associated with studies addressing risk factors in supply chains and logistics activities, while, interconnectedness risk factor group was referred relatively lower.

On the other hand, behavioral and moral related risk factors were addressed in minority in the selected articles.

5.1.5. Discussion on the Supply Chain Risk Factors in Food Supply Chains from a TBL Perspective:

The interviews with forty one members of food supply chains and the observations at twenty eight sites addressed twenty three risk factors, which were highlighted to be considered as the causes of supply chain risks from a TBL perspective. The outstanding risk factors were then tagged with the most appropriate words addressing the key focus in discussions. This was done by referring to the relevant literature on the entitled risk factors. As a result, twenty three different risk factors were coded, as follows: complacency, capability, control, dependence, consciousness, ethics, governance, inertia, opportunism, employee, legality, health and safety, information, quality, resource, traceability, reputation, seasonality, stakeholder, self-focus, planning, structural, and perception risk factors.

Later, the titles of twenty three risk factors were reviewed in a specified literature domain, namely the *web of knowledge*, across the articles with *risk* in title, and *supply chain* or *logistics* in topic, in order to explore whether related tasks had been previously addressed in relevant articles, and with which frequency. Although the selected articles do not cover the complete literature on the issue, it helped to ensure that the titles of the risk factors were in line with current research. Among twenty three of the risk factors, nine, namely quality, information, safety, control, planning, perception, health, labor, legal, and reputation, were referred to directly with the given titles. Others, namely dependence, resource, structural, governance, seasonality, traceability, capability, stakeholder, consciousness, self-focus, ethics, opportunism related risk factors, although referred in explanations, have not been directly coded as given. Especially, dependence related risk factors were identified to be frequently reported while exemplifying the risk factors in supply chain and logistics. On the other hand, complacency and inertia related factors were not addressed in the discussions of the selected articles.

Those risk factors were then grouped based on the fundamental focus of emphasis in the related discussions of each risk factor, which were then validated by the three academicians (Berg, 2001; Creswell, 2007). As a result, five groups were identified, namely behavioral, managerial, moral, competence and interconnectedness risk factors. Although behavioral and competence risk factors were identified to be directly referred in the related articles, three factors, namely, managerial, moral and interconnectedness risk factors, were mentioned in discussions only, especially with a very frequent citation of managerial risk factors.

Therefore, by referring to the relevant literature and to the results of manifest content analysis, the titles of the risk factors were revised when necessary, and validated accordingly. The results of those analyses indicate that, especially consciousness, self-focus, ethics, and opportunism risk factors, which were coded based on the notes of the multiple-case study, were addressed in a minority of the related articles, and also four to be infrequent in the relevant literature, while complacency and inertia risk factors were not addressed at all. Therefore, additional to identifying twenty three risk factors in supply chain logistics operations in food supply chains, revealing those non-referred or less referred risk factors in food supply chains can be considered as one important contribution of the multiple-case study conducted in this thesis.

5.1.6. Food Supply Chain Risk Factors from a Generic Perspective

By referring to the discussions on Chapter III, it could be stated that, the risk factors identified in the multiple-case study address the causes of risks offered by certain theories.

In behavioral risk factors, any factor which affects the behaviors of supply chain members was considered to cause risks in food supply chains. Within this perspective, constraints discussed in stakeholder theory which implies morals, values or ethics could be considered to be the theory to explain the generic risk factors for food supply chains, when behavioral aspects were addressed. The main concern of stakeholder theory is to explain the dynamics of relationships between different groups, resulting from different levels of interactions and change affecting the whole

organization and all the businesses (Phillips et al., 2003; Parmar et al., 2010), which might refer and explain the complacent behaviors, misperceptions, unconsciousness behaviors, labor related issues and other reputational issues related to individuals.

On the other hand, moral risk factors, especially the opportunism risk factor, were addressed by the constraints explained in agency theory, which highlights the goal conflict provided by the self-interest between the principal and the agent (Ross, 1973; Eisenhardt, 1988). The behavior of actors in the interest of their company or functional area when unanticipated events were faced would cause unethical opportunistic behavior. Therefore, the risk factors discussed in moral risk factors could be explained by the constraint arguments of agency theory.

On the other hand, managerial risk factors were mostly related with the discussions in institutional theory and transaction cost economics theory. Institutional theory focuses on managing industrial dynamics and relationships, and refers to the constraint arguments related to the need for isomorphism to garner legitimacy (Scott, 1987; Lin and Sheu, 2012), while transaction cost economics views organizations as governance structures with trading partners to be governed (Shelanski and Klein, 1995; Williamson, 1998). When considered from this perspective, managerial risk factors related to control, governance, legality, self-focus issues as well as planning, inertia, health and safety, could be explained by the constraint arguments of these two theories.

Furthermore, in competence risk factors, the capability and quality related risk factors as well as resource, traceability and information related risk factors could be explained by the constraint arguments of the resource-based view, dynamic capabilities as well as the natural resource based view. In the resource-based view, internal capabilities are mostly considered to be the bundles of differentiated resources, providing competence and carrying an organization to success (Eisenhardt and Martin, 2000, Barney, 2001), whereas in dynamic capabilities, it is argued that there is a need to integrate both internal and external resources to rapidly changing environment to achieve competitiveness (Eisenhardt and Martin, 2000; Winter, 2003). Additionally, the adaptation to the natural environment for achieving sustainable competitive advantage (Hart and Dowell, 2010) is further emphasized in the natural resource-based view. Therefore, the competence related risk factors could be

explained by the arguments provided by the resource-based view, dynamic capabilities and the natural resource-based view.

On the other hand, the structural factors, stakeholder related issues, seasonality factors as well as other dependencies grouped by interconnectedness risk factors could be explained by the framework provided by resource dependence theory, which emphasizes that organizations are dependent on external contingencies (Pfeffer and Salancik, 1978; Paulraj and Chen, 2007). Therefore, the interdependencies of organizations and other external contingencies could be explained by the arguments of resource dependence theory.

5.2. ANALYSIS OF MULTIPLE CASE DATA

5.2.1. Within Case Analysis in Food Supply Chains

In order to outline which supply chain risk factors are emphasized more, and which took relatively less attention in each case, the frequency of emphasis on each risk factor in multiple-case study data was counted within each five of the food supply chains. The results of the analysis address to the third research question of the thesis study, which requires the exploration of risk factors addressed at each type of food supply chain.

5.2.1.1. Meat Supply Chain

The frequency of emphasis on each group of risk factor was counted in meat supply chains first, in order to outline how many times the respondents in meat supply chain addressed to the particular risk factor (Table 15).

Table 15: The Degree of Emphasis on Risk Factor Groups in Meat Supply Chain

MEAT SUPPLY CHAIN		
Risk Factor Group	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Managerial Risk Factors	418	33%
Behavioral Risk Factors	408	32%
Competence Risk Factors	274	22%
Moral Risk Factors	124	10%
Interconnectedness Risk Factors	50	4%

For the meat supply chain, managerial risk factors were the most mentioned, with 33%, closely followed by the behavioral risk factors, with 32%. This emphasis on managerial and behavioral risk factors was followed by competence risk factors (22%). Moral risk factors and interconnectedness risk factors were mentioned in minority by 10% and 4% respectively. In order to outline which titles of risk factors dominate the risk factor group, the frequency of references for twenty-three risk factors in meat supply chain were calculated as shown in Table 16.

Table 16: The Degree of Emphasis on Risk Factors in Meat Supply Chain

MEAT SUPPLY CHAIN			
Risk Factor Group	**Risk Factor**	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Behavioral RF	Consciousness RF	286	22%
Managerial RF	Control RF	146	11%
Managerial RF	Health and Safety RF	135	11%
Moral RF	Opportunism RF	100	8%
Competence RF	Capability RF	75	6%
Competence RF	Resource RF	62	5%
Managerial RF	Governance RF	59	5%
Competence RF	Quality RF	54	4%
Competence RF	Traceability RF	50	4%
Behavioral RF	Complacency RF	41	3%
Behavioral RF	Labor RF	37	3%
Competence RF	Information RF	33	3%
Behavioral RF	Perception RF	29	2%
Managerial RF	Self-Focus RF k	27	2%
Moral RF	Ethics RF	24	2%
Managerial RF	Planning RF	22	2%
Interconnectedness RF	Dependence RF	18	1%
Behavioral RF	Reputation RF	15	1%
Managerial RF	Inertia RF	15	1%
Managerial RF	Legality RF	14	1%
Interconnectedness RF	Structural RF	12	1%
Interconnectedness RF	Stakeholder RF	12	1%
Interconnectedness RF	Seasonality RF	8	1%

In managerial risk factors, the main emphasis was given on control and health and safety risk factors (each 11%, of 33%). In behavioral risk factors, most of the discussions were addressing to consciousness risk factors by 22% of 32%; while others with an effect in minority. In competence risk factors, almost all five risk factors have similar effects; except information risk factor, by 3%. In moral risk factors, the main emphasis of discussions was caused by opportunism related risk factors, by 8% of 10%, whereas in interconnectedness risk factors, all four risk factors have similar effects.

Therefore, this detailed look into the risk factors from the view provided by the meat supply chains outlines that the major cause of risks in food supply chain logistics operations were related to consciousness factors, with 22%. This was

followed, though not closely, by control and health and safety related factors, with 11% each. Besides, the impact of opportunism risk was also undeniable among others, with 8%.

5.2.1.2. Chicken Supply Chain

The sequence of emphasis on risk factors was almost the same as meat supply chain in chicken supply chain, with a minor exception of only behavioral risk factors moving over managerial risk factors by 1% (Table 17).

Table 17: The Degree of Emphasis on Risk Factor Groups in Chicken Supply Chain

CHICKEN SUPPLY CHAIN		
Risk Factor Group	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Behavioral Risk Factors	360	33%
Managerial Risk Factors	339	32%
Competence Risk Factors	219	20%
Moral Risk Factors	119	11%
Interconnectedness Risk Factors	39	4%

The behavioral risk factor was dominated by consciousness related risk factors (24% of 33% respectively), while managerial risk factors were dominated by control and health and safety related risk factors (each 11%, of 32%) as shown in Table 18.

Table 18: The Degree of Emphasis on Risk Factors in Chicken Supply Chain

CHICKEN SUPPLY CHAIN			
Risk Factor Group	**Risk Factor**	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Behavioral RF	Consciousness RF	260	24%
Managerial RF	Control RF	116	11%
Managerial RF	Health and Safety RF	115	11%
Moral RF	Opportunism RF	95	9%
Competence RF	Resource RF	55	5%
Competence RF	Capability RF	54	5%
Managerial RF	Governance RF	48	4%
Competence RF	Traceability RF	41	4%
Competence RF	Quality RF	40	4%
Behavioral RF	Complacency RF	35	3%
Competence RF	Information RF	29	3%
Behavioral RF	Labor RF	27	3%
Behavioral RF	Perception RF	25	2%
Moral RF	Ethics RF	24	2%
Managerial RF	Self-Focus RF	21	2%
Managerial RF	Planning RF	17	2%
Behavioral RF	Reputation RF	13	1%
Managerial RF	Inertia RF	13	1%
Interconnectedness RF	Dependence RF	13	1%
Interconnectedness RF	Structural RF	12	1%
Managerial RF	Legality RF	9	1%
Interconnectedness RF	Stakeholder RF	9	1%
Interconnectedness RF	Seasonality RF	5	0%

On the other hand, the emphasis of competence risk factors, with 20%, was distributed among other risk factors almost equally, except information risk, with a minor effect with 3% relatively. Among moral risk factors, opportunism risk has a remarkable effect, with 9% of 11%. Interconnectedness risk factor was again little mentioned in chicken supply chain (4%), in which seasonality effect was almost not emphasized (0.5%).

Therefore, in chicken supply chains, the effect of consciousness risk factors in food supply chain logistics operations was remarkably high, with 24%, when compared with others. It was followed, though not closely, by control and health and safety related factors with equal weights with 11% each. As in meat supply chains, opportunism risk factors were also considered a substantial trigger of risks, with 9%.

5.2.1.3. Dairy Product Supply Chains

The content of the discussions in dairy product supply chains were similar to chicken supply chains. Behavioral risk factors were the most mentioned during the interviews, with 32%, followed by the managerial risk factors, with 31% (Table 19).

Table 19: The Degree of Emphasis on Risk Factor Groups in Dairy Product Supply Chain

DAIRY PRODUCT SUPPLY CHAIN		
Risk Factor Group	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Behavioral Risk Factors	389	32%
Managerial Risk Factors	370	31%
Competence Risk Factors	246	20%
Moral Risk Factors	135	11%
Interconnectedness Risk Factors	61	5%

The percentage of consciousness risk factors in behavioral risk factors was 23% (of 32%), whereas managerial risk factors were mostly dominated by control risk factors by 11% and health and safety risk factors by 10% of 31% (Table 20).

Behavioral and managerial risk factors were then followed by competence risk factors, by 20%, in which almost all other risk factors were mentioned with equal frequency, except information risk, with a relatively low weight (3%). The proportion of opportunism risk in moral risk factors was again 9% of 11%. Differently, interconnectedness risk factors were relatively highly mentioned in dairy product supply chains, with 5%, in which the risk factor, dependence, dominates by 2% (Table 20).

Table 20: The Degree of Emphasis on Risk Factors in Dairy Product Supply Chain

DAIRY PRODUCT SUPPLY CHAIN			
Risk Factor Group	**Risk Factor**	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Behavioral RF	Consciousness RF	279	23%
Managerial RF	Control RF	129	11%
Managerial RF	Health and Safety RF	122	10%
Moral RF	Opportunism RF	106	9%
Competence RF	Capability RF	63	5%
Competence RF	Resource RF	58	5%
Managerial RF	Governance RF	49	4%
Competence RF	Quality RF	45	4%
Competence RF	Traceability RF	44	4%
Behavioral RF	Complacency RF	39	3%
Competence RF	Information RF	36	3%
Behavioral RF	Labor RF	32	3%
Moral RF	Ethics RF	29	2%
Behavioral RF	Perception RF	26	2%
Managerial RF	Self-Focus RF	23	2%
Interconnectedness RF	Dependence RF	21	2%
Managerial RF	Legality RF	18	1%
Managerial RF	Planning RF	17	1%
Interconnectedness RF	Stakeholder RF	17	1%
Interconnectedness RF	Structural RF	14	1%
Behavioral RF	Reputation RF	13	1%
Managerial RF	Inertia RF	12	1%
Interconnectedness RF	Seasonality RF	9	1%

Therefore, consciousness risk factor was considered to be the biggest cause of risks in food supply chain logistics operations, with 23%. Control risk factors follow, though not closely, with 11%. Besides, health and safety risk factors and opportunism risk factors also have a substantial place on discussions, as being the important triggers causing risks in food supply chains by 10% and 9% respectively.

5.2.1.4. Fish Supply Chains

Lastly, in fish supply chains, behavioral risk factors was the most mentioned, with 32%, followed closely by managerial risk factors, with 31% each (Table 21).

Table 21: The Degree of Emphasis on Risk Factor Groups in Fish Supply Chain

FISH SUPPLY CHAIN		
Risk Factor Group	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Behavioral Risk Factors	376	32%
Managerial Risk Factors	364	31%
Competence Risk Factors	235	20%
Moral Risk Factors	124	11%
Interconnectedness Risk Factors	65	6%

The consciousness risk factor has again a prominent emphasis among behavioral risk factors with 23%, while control and health and safety risk factors have a prominent emphasis among managerial risk factors, with 10% each (Table 22).

Table 22: The Degree of Emphasis on Risk Factors in Fish Supply Chain

FISH SUPPLY CHAIN			
Risk Factor Group	**Risk Factor**	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Behavioral RF	Consciousness RF	270	23%
Managerial RF	Control RF	121	10%
Managerial RF	Health and Safety RF	117	10%
Moral RF	Opportunism RF	102	9%
Competence RF	Capability RF	62	5%
Competence RF	Resource RF	57	5%
Managerial RF	Governance RF	56	5%
Competence RF	Traceability RF	44	4%
Competence RF	Quality RF	41	4%
Behavioral RF	Complacency RF	37	3%
Competence RF	Information RF	31	3%
Behavioral RF	Perception RF	28	2%
Behavioral RF	Labor RF	28	2%
Interconnectedness RF	Dependence RF	27	2%
Managerial RF	Self-Focus RF	25	2%
Moral RF	Ethics RF	22	2%
Managerial RF	Planning RF	19	2%
Interconnectedness RF	Stakeholder RF	15	1%
Managerial RF	Inertia RF	14	1%
Behavioral RF	Reputation RF	13	1%
Interconnectedness RF	Structural RF	13	1%
Managerial RF	Legality RF	12	1%
Interconnectedness RF	Seasonality RF	10	1%

Similar to other food supply chain types, competence risk factor follows behavioral and managerial risk factors with 20%, in which again all risk factors were mentioned almost equally, except information risk factor, with a relatively low percentage of 3%. On the other hand, opportunism risk again dominates the moral risk factor related discussions by 9% of 11%, while interconnectedness risk factors were mentioned in minority by 6% in general. However, the percentage of interconnectedness risk factor in fish supply chains were relatively higher than all other food supply chain types, with the emphasis on dependence related risk factors by 2%.

Therefore, the consciousness risk factor was considered to be the biggest cause of risks in food supply chain logistics operations, with 23%. Control risk factors, as well as health and safety risk factors and opportunism risk factors follow, with 10%, 10% and 9% respectively.

5.2.1.5. Retail Food Supply Chains

Similarly, in retail food supply chains, managerial risk factors leaded the emphasis of discussions, with 33%, which was closely followed by behavioral risk factors, with 32%, as presented in Table 23.

Table 23: The Degree of Emphasis on Risk Factor Groups in Retail Food Supply Chain

RETAIL FOOD SUPPLY CHAIN		
Risk Factor Group	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Managerial Risk Factors	397	33%
Behavioral Risk Factors	388	32%
Competence Risk Factors	237	20%
Moral Risk Factors	132	11%
Interconnectedness Risk Factors	47	4%

This time the control risk factors were more mentioned by 12%, while addressing managerial risk factors, whereas health and safety risk factors follow by

10% (Table 24). Besides, consciousness risk factors were mentioned most (23% of 32%) while addressing behavioral risk factors.

Table 24: The Degree of Emphasis on Risk Factors in Retail Food Supply Chain

RETAIL FOOD SUPPLY CHAIN			
Risk Factor Group	**Risk Factor**	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Behavioral RF	Consciousness RF	278	23%
Managerial RF	Control RF	149	12%
Managerial RF	Health and Safety RF	119	10%
Moral RF	Opportunism RF	102	8%
Competence RF	Resource RF	61	5%
Competence RF	Capability RF	59	5%
Managerial RF	Governance RF	57	5%
Competence RF	Quality RF	44	4%
Competence RF	Traceability RF	42	3%
Behavioral RF	Complacency RF	37	3%
Competence RF	Information RF	31	3%
Behavioral RF	Labor RF	31	3%
Moral RF	Ethics RF	30	2%
Behavioral RF	Perception RF	28	2%
Managerial RF	Self-Focus RF	26	2%
Managerial RF	Planning RF	22	2%
Interconnectedness RF	Stakeholder RF	16	1%
Behavioral RF	Reputation RF	14	1%
Managerial RF	Inertia RF	13	1%
Interconnectedness RF	Dependence RF	13	1%
Interconnectedness RF	Structural RF	12	1%
Managerial RF	Legality RF	11	1%
Interconnectedness RF	Seasonality RF	6	0%

Managerial and behavioral risk factors were followed by competence risk factors, with 20%, in which almost all risk factors were mentioned equally, except information risk, with only a minor effect, with 3% relatively (Table 24). Moreover, the effect of opportunism risk factor in moral risk factor group was clearly important with 8% of 11%. On the other hand, interconnectedness risk factor was not an important focus of discussions in retail food supply chains, with only 4%.

Therefore, in retail food supply chains, it is obvious that consciousness risk factor was considered to be the biggest cause of risks in food supply chain logistics

operations, with 23%. Control risk factors follow them, though not closely, with 12%. Besides, health and safety risk factors and opportunism risk factors also have a substantial place in discussions, as being the important triggers causing risks in food supply chains, with 10% and 8% respectively.

5.2.1.6. General Evaluation on Within Case Analysis

As presented in Table 25 and 26, the figures that were calculated by considering the complete data also indicates that behavioral risk factors were most mentioned, closely followed by managerial risk factors.

Table 25: The Degree of Emphasis on Risk Factor Groups in General

ALL FOOD SUPPLY CHAIN TYPES		
Risk Factor Group	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Behavioral Risk Factor	1921	32%
Managerial Risk Factor	1888	32%
Competence Risk Factor	1211	20%
Moral Risk Factor	634	11%
Interconnectedness Risk Factor	262	4%

Besides, when the data was probed in detail, it is clear that consciousness risk factors were much more frequently mentioned relative to others (Table 26). Though not closely, control, health and safety and opportunism risk factors follow consciousness risk factors as the other risk factors to be considered critically.

Table 26: The Degree of Emphasis on Risk Factors in General

ALL FOOD SUPPLY CHAIN TYPES		
Risk Factor	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Consciousness RF	1373	23%
Control RF	661	11%
Health and Safety RF	608	10%
Opportunism RF	505	9%
Capability RF	313	5%
Resource RF	293	5%
Governance RF	269	5%
Quality RF	224	4%
Traceability RF	221	4%
Complacency RF	189	3%
Information RF	160	3%
Labor RF	155	3%
Perception RF	136	2%
Ethics RF	129	2%
Self-Focus RF	122	2%
Planning RF	97	2%
Dependence RF	92	2%
Stakeholder RF	69	1%
Reputation RF	68	1%
Inertia RF	67	1%
Legality RF	64	1%
Structural RF	63	1%
Seasonality RF	38	1%

In summary, within case analysis of the multiple case study indicates that the ranking of the emphasis of risk factors in interview discussions follow a similar sequence in meat, chicken, retail food, dairy products and fish supply chains. In almost all food supply chain types, behavioral risk factors caused especially by consciousness related issues, and managerial risk factors caused especially by control and health and safety related issues were most highlighted. Competence risk factors follow managerial and behavioral risk factors, but with no particular emphasis on any related risk factors. Besides, opportunism risk factors of moral risk factor group have a remarkable emphasis. Moreover, interconnectedness risk factors were referred by a minority, which show that this is the risk factor group deserves much less emphasis in food supply chains.

5.2.1.7. Evaluating the Findings of Within Case Analysis with the Results of Manifest Content Analysis

When the findings of the within case analysis of multiple-case study was compared with manifest content analysis results, it has been identified that, although consciousness, control, health and safety and opportunism risk factors were heading the discussions in multiple-case study, control and health and safety risk factors were directly or indirectly addressed in the articles and across related literature, while consciousness and opportunism risk factors were mentioned remarkably very limited. Besides, complacency risk factor, which was mentioned for 189 times, and inertia risk factor, which was mentioned for 67 times during the multiple-case study were never referred. On the other hand, behavioral and competence risk factors were identified to be directly entitled in the articles, whereas managerial, moral and interconnectedness risk factors, though mentioned in the discussions, were not. However, still, behavioral risk factors and moral risk factors were identified to be referred very limited in the articles.

This comparison indicates that behavioral risk factors, especially consciousness, as being the most frequently mentioned risk factor in the multiple-case study, has not been adequately addressed in the articles, and across related literature. This requires a need for an increased attention on behavioral risk factors, for not only consciousness related tasks, but also for complacency and others as well. Besides, inertia risk factor in managerial risk factor group, as well as opportunism risk factor in moral risk factor group, still deserves greater attention with an impact of considerably higher rates.

These results address to a new direction for research in sustainability approached risk management studies in supply chain and logistics field; thus, can be considered as an important contribution to the relevant literature, as well as the practice.

5.2.2. Cross Case Analysis in Food Supply Chains

In cross case analysis, the same figures were this time evaluated across different food supply chain types in order to identify patterns, by rearranging the case by case format into construct by construct. Therefore, now the percentages of each risk factor group were calculated in terms of the emphasis among different food supply chain types, and those percentages were then compared with respect to their frequency of emphasis. Here, the comparisons are only based on the figures provided by the risk factors groups, as the focus of emphasis in each risk factor group was clearly outlined in within case discussions. The findings of the cross case analysis address to the forth research question, which seeks to outline how risk factors differ across different food supply chain types.

As shown in Table 27, competence risk factors, although emphasized mostly by meat supply chain (23%), were mentioned with almost equal frequencies at each food supply chain, with minor differences.

Table 27: Frequency and Percentage of Emphasis of Competence Risk Factor Group across Food Supply Chain Types

	Competence Risk Factors	
Type Of Food SC	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Meat SC	274	23%
Dairy Products SC	246	20%
Retail Food SC	237	20%
Fish SC	235	19%
Chicken SC	219	18%

The figures are very close in terms of the emphasis of behavioral risk factors across different types of food product supply chains, as presented in Table 28. Although behavioral risk factors were mostly mentioned in meat supply chain, with 21%, it is very closely followed by dairy products, retail food and fish supply chains, equally with 20%. In chicken supply chain, the emphasis was slightly less, but still remarkably closer to others, with 19%.

Table 28: Frequency and Percentage of Emphasis of Behavioral Risk Factor Group across Food Supply Chain Types

	Behavioral Risk Factors	
Type Of Food SC	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Meat SC	408	21%
Dairy Products SC	389	20%
Retail Food SC	388	20%
Fish SC	376	20%
Chicken SC	360	19%

On the other hand, managerial risk factors were mentioned most in meat supply chains, with 22%, which is again closely followed by dairy products and retail food, with 21% and 20% respectively (Table 29). It could be stated that the emphasis of managerial risk factors in fish and chicken supply chains was relatively less than the others. However, it is still remarkably close, with 19% and 18% respectively.

Table 29: Frequency and Percentage of Emphasis of Managerial Risk Factor Group across Food Supply Chain Types

	Managerial Risk Factors	
Type Of Food SC	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Meat SC	418	22%
Dairy Products SC	397	21%
Retail Food SC	370	20%
Fish SC	364	19%
Chicken SC	339	18%

The figures are very close in terms the emphasis on moral risk factors for all types of food supply chains (Table 30). Meat and dairy product supply chain mentioned moral issues most with 21% each, which is very closely followed by retail food and fish, with 20% each, and slightly less mentioned in chicken, with 19%.

Table 30: Frequency and Percentage of Emphasis of Moral Risk Factor Group across Food Supply Chain Types

	Moral Risk Factors	
Type Of Food SC	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Meat SC	135	21%
Dairy Products SC	132	21%
Retail Food SC	124	20%
Fish SC	124	20%
Chicken SC	119	19%

Interconnectedness risk factor is the groups of risk factors in which relatively larger variations exist between the food supply chain types (Table 31). Meat supply chain mentioned this risk factor most, with 25%, which is followed by dairy products supply chain, with 23%. Retail food and fish supply chain emphasized this risk factor relatively less than dairy products, with 19% and 18% respectively, after which chicken supply chain takes its place with a lower rate of 15%.

Table 31: Frequency and Percentage of Emphasis of Interconnectedness Risk Factor Group across Food Supply Chain Types

	Interconnectedness Risk Factors	
Type Of Food SC	**Number of References on Risk Factors**	**Percentage of References on Risk Factors**
Meat SC	65	25%
Dairy Products SC	61	23%
Retail Food SC	50	19%
Fish SC	47	18%
Chicken SC	39	15%

The above figures show, no clear pattern in different food supply chains exists in terms of their emphasis on different risk factors. Each one of the risk factor was emphasized to the same extent in every type of food supply chain. This indicates that there are no huge variations or differences across cases in terms of their concerns on managerial, behavioral, moral, interconnectedness or competence related issues.

The only relatively remarkable variation was observed in interconnectedness risk factor, which was rated by 25% in meat supply chain, but only by 15% in chicken supply chain. This might be because the supply network design of meat supply chain is relatively more complex than chicken supply chain.

5.3. CONCEPTUAL MODEL OF SUPPLY CHAIN RISK FACTORS

The scope of the multiple-case study and interviews within the scope of this research covers several members from different food supply chains at different levels. This helped to outline some interactions among five of the risk factor groups; some risk factors trigger others, some are triggered by others, or some affect each other. In order to convert this data know-how into a conceptual model, ISM methodology has been applied to the findings.

ISM methodology provides a direction for outlining and communicating complex issues, especially in cases where unclear, complex and poor tasks are challenged to be converted into structured models. One important drawback of ISM relates to the possible bias created by the researcher judging and assessing the situations, and another is related to the tasks that are not weighted and evaluated based on their relative importance (Diabat, Govindan and Panicker, 2012).

Although applied by several researchers to different research problems (Bolanos et al., 2005; Faisal, 2010b; Alawamleh and Popplewell, 2011; Shahabadkar, 2012; Attri, Dev and Sharma, 2013), with similar research area and clear flowchart given, Diabat, Govindan and Panicker (2012)'s work on modeling supply chain risks in food industry provided us a reference of direction in applying ISM (Figure 9).

Following this framework, pairwise comparisons were made based on the risk factors identified through the multiple-case study and the comprehensive literature review in order to outline the contextual relationships in between. During the interviews, not only the contextual relationship for each source, but also the existence of a relationship and associated direction of their relations between the two risk factors (*i* and *j*) were outlined. Therefore, the SSIM was developed accordingly. Here, the symbols indicating the direction of relationships were assigned to the pairwise comparison of risks, based on the qualitative data outlined from semi-

structured interviews and observations. Despite the relationships being coined primarily based on the interview and observation data collected, they also were supported by the researcher, who probed the issues in depth and observed the environment and direct response and reactions of the interviewees.

The steps of ISM methodology are adopted within the context of this research as follows (Faisal, Banwet and Shankar, 2007:684):

Step 1: Supply chain risk factors are listed.
Step 2: From the supply chain risk factors listed in Step 1, a contextual relationship is established among variables with respect to which pairs of supply chain risk factors would be examined.
Step 3: SSIM is developed for supply chain risk factors, which indicates pairwise relationships among supply chain risk factors of the system under consideration.
Step 4: Reachability matrix is developed from the SSIM, and the matrix is checked for transitivity. The transitivity of the contextual relation is a basic assumption made in ISM which states that if a variable A is related to B, and B is related to C, then A is necessarily related to C.
Step 5: The reachability matrix obtained in Step 4 is partitioned into different levels.
Step 6: Based on the relationships given above in the reachability matrix, a directed graph is drawn and the transitive links are removed.
Step 7: The resultant digraph is converted into an ISM, by replacing supply chain risk factors nodes with statements.
Step 8: The ISM model developed in Step 7 is reviewed to check for conceptual inconsistency, and necessary modifications are made.

The contextual relationship between the variables was defined as influence relationship (Diabat, Govindan and Panicker, 2012). Symbols were assigned to each pair based on different direction of relationships; V (if risk factor *i* will help to alleviate risk factor *j*), A (if risk factor *i* will be alleviated by risk factor *j*), X (risk factor *i* and *j* will help to alleviate each other), O (risk *i* and *j* are unrelated) (Diabat, Govindan and Panicker, 2012).

Based on the assigned relationships, the SSIM is figured in Table 32;

Table 32: Structural Self-Interaction Matrix for Risk Factor Groups

RISK FACTOR GROUPS		Int. RF 5	Mor. RF 4	Man. RF 3	Beh. RF 2	Comp. RF 1
Comp. RF	1	V	X	X	A	-
Beh. RF	2	O	V	V	-	-
Man. RF	3	V	X	-	-	-
Mor. RF	4	A	-	-	-	-
Int. RF	5	-	-	-	-	-

Based on SSIM matrix, initial reachability matrix was created (Table 33). In reachability matrix, symbols were re-denoted by binary numbers; 0 and 1. In cases where (*i*,*j*) entry in SSIM is V, (*i*,*j*) entry is assigned 1, whereas (*j*,*i*) is assigned 0; in cases where (*i*,*j*) entry in SSIM is A, (*i*,*j*) entry is assigned 0, whereas (*j*,*i*) is assigned 1; in cases where (*i*,*j*) entry in SSIM is X, (*i*,*j*) entry is assigned 1, whereas (*j*,*i*) is assigned 1; in cases where (*i*,*j*) entry in SSIM is O, (*i*,*j*) entry is assigned 0, whereas (*j*,*i*) is assigned 0 (Diabat et al., 2012).

Table 33: Initial Reachability Matrix of Risk Factor Groups – Iteration I

RM-I	1	2	3	4	5	Driver Power
1	1	0	1	1	1	**4**
2	1	1	1	1	0	**4**
3	1	0	1	1	1	**4**
4	1	0	1	1	0	**3**
5	0	0	0	1	1	**2**
Dependence Power	**4**	**1**	**4**	**5**	**3**	

Based on the transitivity rule, which states that if a variable 'A' is related to 'B', and 'B' is related to 'C', then 'A' is necessarily related to 'C', initial reachability matrix was then transformed into final reachability matrix, as in Table 34 (Daiabat et al., 2012, 3042).

Table 34: Final Reachability Matrix of Risk Factor Groups – Iteration I

RM-I	1	2	3	4	5	Driver Power
1	1	0	1	1	1	**4**
2	1	1	1	1	1	**5**
3	1	0	1	1	1	**4**
4	1	0	1	1	1	**4**
5	1	0	1	1	1	**4**
Dependence Power	**5**	**1**	**5**	**5**	**5**	

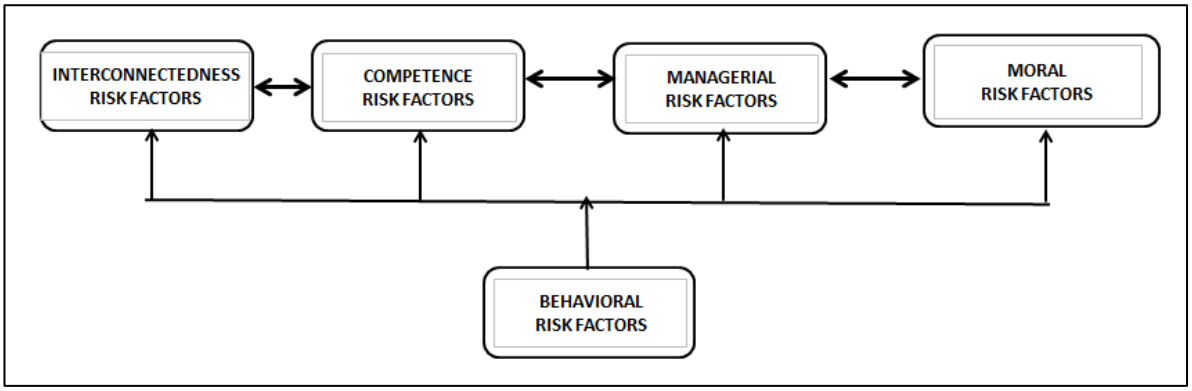
Level partition matrix was created, based on the driver power and dependence power ranking, as in Table 35;

Table 35: Level Partition Matrix of Supply Chain Risk Factor Groups

Risk Factors	Reachability Set	Antecedent Set	Intersection	Level
Competence RF	1345	12345	1345	**I**
Behavioral RF	12345	2	2	
Managerial RF	1345	12345	1345	**I**
Moral RF	1345	12345	1345	**I**
Interconnectedness RF	1345	12345	1345	**I**

The conceptual model was then outlined by ISM process, which presents the contextual relationships, and the interactions between the risk factors (Figure 11), and thus, addresses to the fifth research question.

Figure 11: Conceptual Model of Supply Chain Risk Factor Groups



Source: Created by the Author

This model presents that alleviating interconnectedness risk factors, competence risk factors, managerial risk factors or moral risk factors would not help alleviating any risk factor above their own level. Here, the only risk factor that can alleviate others is identified as the behavioral risk factors. This shows that, for companies in developing strategies for risk management, focusing on alleviating

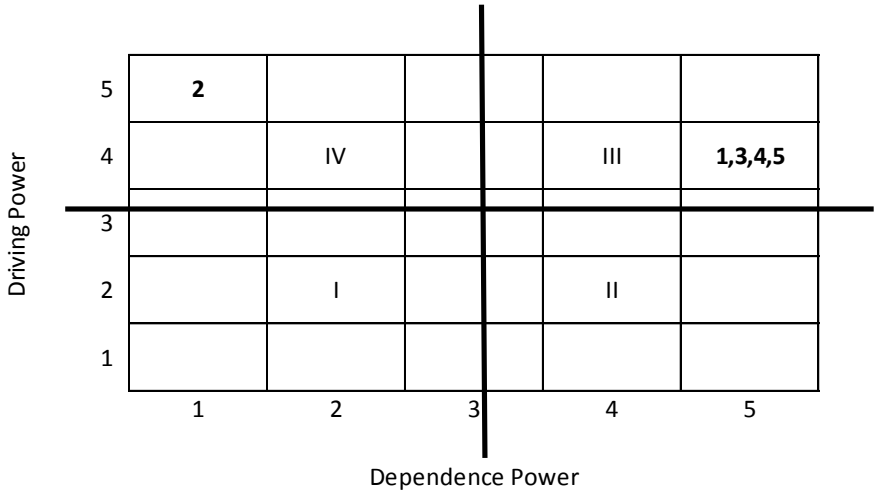
behavioral risk factors is necessarily important to alleviate all other four risk factors. Therefore, strategies should be developed for mitigating behavioral risk factors in supply chain management, especially in the food industry.

This model shows the significance of behavioral risk factors in supply chain logistic operations and emphasizes its importance in terms of avoiding risks related to other factors, such as managerial, competence, moral, and interconnectedness. This finding also supports the multiple-case study results, in which behavioral risk factors were identified to be the most highly mentioned risk factor group while discussing risk factors in food supply chains from a sustainability perspective.

Based on the reachability matrix, the driving power and the dependence of the elements was figured out through MICMAC analysis, and the autonomous risk factors (I), dependent risk factors (II), linkage risk factors (III) and independent risk factors (IV) were outlined accordingly as shown in Figure 12.

The variables in the first cluster are autonomous risk factors, which have weak driving power and weak dependence power. This means that the variables in this cluster have very few links with others, and thus are relatively disconnected from the system. In our analysis, none of the variables fall into this group. Therefore, all risk factors are connected to the system and should be considered by supply chain members while developing risk strategies. The second cluster is the dependent risk factors having weak driving power and strong dependence power. The variables at this cluster are mostly the resulting factors. The third cluster is the linkage risk factors which have strong driving power and strong dependence power. That means any change in any of the variables in this cluster will have an effect on others, and a feedback on themselves. All four risk factors, namely the competence, moral, managerial and interconnectedness risk factors fall into this cluster influencing other risk factors. Therefore, any action to mitigate those risk factors will affect others as well as themselves. The fourth cluster is the independent risk factors which have strong driving power and weak dependence power. Only behavioral risk factors fall into this cluster meaning that this is the only key risk factor compared to others, and should be considered as the root cause risk factor within the scope.

Figure 12: MICMAC Analysis of Supply Chain Risk Factor Groups



The ISM model helped to outline and visualize the hierarchy of risk factors identified in the multiple-case study which have interrelationships sometimes difficult to understand. ISM provided to outline a logical structure showing the relationships between those different risk factors and model them in a comprehensive manner. However, with this model analysis, it is not possible to quantify the risk factors. This could be done through some other complementary analysis, such as Delphi, AHP, ANP, SEM or fuzzy logic (Alawamleh and Popplewell, 2011).

This research has focused on formulating a fuzzy AHP-based model to prioritize supply chain risks with bigger impact on different dimensions of sustainability.

5.4. DEVELOPING SUSTAINABILITY ORIENTATION TO SUPPLY CHAIN RISKS THROUGH FUZZY AHP

Vagueness and uncertainty in the environment makes decision-making very difficult, and needs to be managed; if not, the results of any assessment can mislead the decision maker. AHP is a semi-quantitative multi-objective decision-making methodology, allowing for the consideration of different decision criteria, and connecting them into one quantitative model. Although AHP is a multi-criteria

decision making methodology which helps the decision-maker to judge each criterion with respect to their relative importance, and assign a preference on each criterion for related decision alternatives, it is not appropriate for a real life decision making problems in cases where fuzziness exist. Such problems are handled by fuzzy theory, which helps to quantify a qualitative value that cannot be assigned precisely. Therefore, the degree of uncertainty is considered through incorporating fuzzy theory in AHP methodology in a decision model. In cases where qualitative assessment is necessary, fuzzy logic is merged with AHP in order to process uncertain variables. The pioneer of fuzzy logic is Zadeh (1965), and is considered to be a major tool for analyzing problems with uncertain parameters. It helps to represent uncertainty and vagueness mathematically.

In this study, the qualitative nature of parameters combined with the uncertainty in decision making process made exploring optimal decision very challenging. Although AHP can cover qualitative variables as well as quantitative ones, it is inadequate for addressing uncertainties. In this respect, Zadeh (1965)'s fuzzy set theory, which approaches and solves problems of uncertain nature, facilitated addressing this vagueness as well as uncertainty. It provided an opportunity to mathematically represent this uncertainty and vagueness, and supported decision-making process in a similar way to human reasoning by its use of approximate information and uncertainty.

Therefore, in this study, fuzzy logic was integrated with AHP. The qualitative risk factor evaluations in terms of environmental, social and economic impacts were adopted as a mean of fuzzy values, which were then transformed into quantitative assessment outcomes. The impacts of each individual risk factor on sustainability-related hazards for all three dimensions of sustainability were identified and evaluated distinctively through fuzzy AHP methodology in terms of their relative importance, depending on each one of the dimensions. This is the part where the sustainability orientation was explicitly developed on supply chain risk factor assessment.

This consideration of quantitative methodologies in the studies focusing on the integration of all three dimensions of sustainability and the interrelations among them are limited, especially for the social dimension (Seuing, 2013). Therefore, this

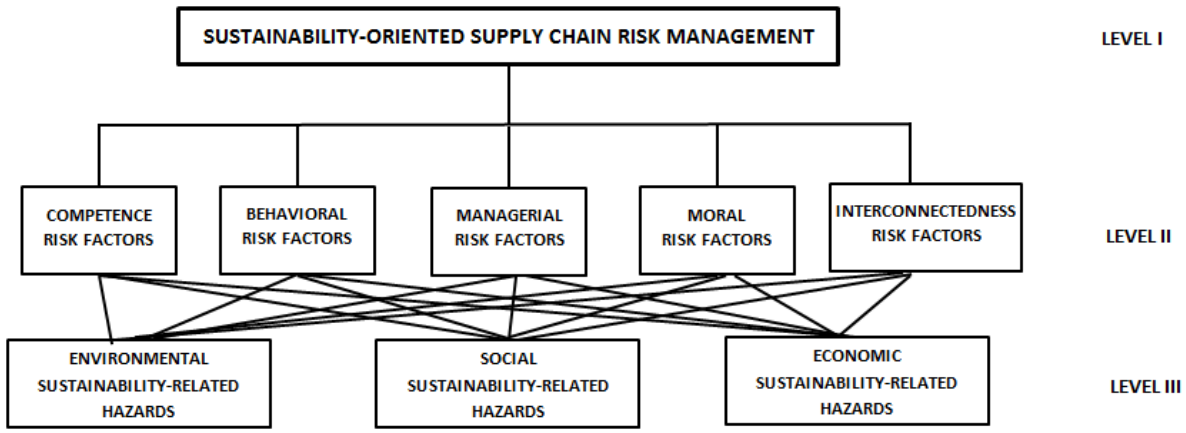
methodological approach would provide useful insights into the use of fuzzy AHP in sustainability-related studies on supply chains, especially with the consideration of all three dimensions (Seuing, 2013).

5.4.1. Hierarchical Structure of the Decision Problem

The fundamental steps in AHP start with elaborating the decision hierarchy through decomposing the decision into sub-independent elements. Therefore, first, the decision problem was represented in a hierarchal view in Figure 13 for visualizing the structure of analysis.

Here in the figure, the main goal of the analysis is given at level I as developing a sustainability-oriented supply chain risk management. The five main risk factor criteria which were evaluated for three alternatives of environmental, social and economic sustainability-related hazards are shown at level II and III respectively.

Figure 13: Hierarchical Structure of the Decision Problem



5.4.2. Fuzzy AHP Calculations

The second step is the part where the importance of criteria was evaluated over a nine-point scale. In this study, pairwise comparisons were established using

this nine-point scale to convert expert preferences into prioritized criteria, such as equally, moderately, strongly, very strongly or extremely preferred, in terms of environmental, social and economic sustainability-related hazards. In this research, fuzzy values of qualitative data were characterized by TFN (Figure 10), which are most commonly used as they are easier to generate (Chan and Kumar, 2007; Wang et al., 2012). Besides, linguistic terms were used in approximate reasoning, and thus the linguistic subjectivity of risk factor evaluations was expressed by TFNs. A preference scale was used to make the comparisons in which numeric values were assigned to different levels of preference (Taylor, 2007). The scale for AHP and fuzzy AHP, which was used in this study, is shown in Table 36;

Table 36: AHP and Fuzzy AHP Scales

Linguistic Variables	SCALE	RECIPROCAL SCALE	TRIANGULAR FUZZY SCALE	TRIANGULAR FUZZY RECIPROCAL SCALE
Equally Preferred	1	1	(1,1,1)	(1/1,1/1,1/1)
Equally to Moderately Preferred	2	½	(1,2,3)	(1/3,1/2,1)
Moderately Preferred	3	1/3	(2,3,4)	(1/4,1/3,1/2)
Moderately to Strongly Preferred	4	¼	(3,4,5)	(1/5,1/4,1/3)
Strongly Preferred	5	1/5	(4,5,6)	(1/6,1/5,1/4)
Strongly to Very Strongly Preferred	6	1/6	(5,6,7)	(1/7,1/6,1/5)
Very strongly Preferred	7	1/7	(6,7,8)	(1/8,1/7,1/6)
Very Strongly to Extremely Preferred	8	1/8	(7,8,9)	(1/9,1/8,1/7)
Extremely Preferred	9	1/9	(8,9,9)	(1/9,1/9,1/8)

Source: Akman and Alkan, 2006

Therefore, in this study, if two activities were assumed to have equal sustainability consequences, the comparison scale would be 1, if one risk factor was assumed to have moderately more negative impacts in terms of sustainability, the analysis scale would be 3. Similarly, scales 5, 7 and 9 were used to describe impacts which are negative, strongly negative, and extremely negative, respectively. The corresponding reciprocals 1, 1/2, 1/3, 1/5, 1/9 were used for the reverse comparison.

The reciprocal matrix was formed by transforming the pairwise comparisons of attributes of e.g. $A = (a_{ij})$ into the reciprocal matrix format of e.g. $a_{ij} = 1/a_{ij}$. That is, when one risk factor, i, was assigned to one of the above nonzero numbers in comparison to another risk factor, j, then j has the reciprocal value when compared to i (Saaty, 1980:6).

In order to determine the priorities of criteria, twelve expert opinions and views were elicited by a questionnaire form (Appendix 2), which involves pairwise comparisons of criteria for each alternative qualitatively. These pairwise comparisons were designed to show how much one criterion has a greater impact than the other on different dimensions of sustainability alternatives. The evaluation matrix for respondent 1 is shown in Table 37. All matrices of the remaining eleven respondents were made in a similar way.

Table 37: Evaluation Matrix for Respondent 1

ENVIRONMENTAL					
1	Comp – RF	Beh – RF	Man – RF	Mor – RF	Int – RF
Comp - RF	1.00	0.14	0.20	3.00	5.00
Beh – RF	7.00	1.00	7.00	7.00	7.00
Man – RF	5.00	0.14	1.00	0.33	5.00
Mor – RF	0.33	0.14	3.00	1.00	7.00
Int - RF	0.20	0.14	0.20	0.14	1.00

SOCIAL					
1	Comp – RF	Beh – RF	Man – RF	Mor – RF	Int – RF
Comp - RF	1.00	0.14	0.20	3.00	5.00
Beh – RF	7.00	1.00	7.00	7.00	7.00
Man – RF	5.00	0.14	1.00	0.33	5.00
Mor – RF	0.33	0.14	3.00	1.00	7.00
Int - RF	0.20	0.14	0.20	0.14	1.00

ECONOMIC					
1	Comp – RF	Beh – RF	Man – RF	Mor – RF	Int – RF
Comp - RF	1.00	5.00	0.20	7.00	5.00
Beh – RF	0.20	1.00	0.20	5.00	3.00
Man – RF	5.00	5.00	1.00	7.00	7.00
Mor – RF	0.14	0.20	0.14	1.00	1.00
Int - RF	0.20	0.33	0.14	1.00	1.00

The comparisons were then transferred into a comparison matrix through the preference scale, using triangular fuzzy linguistic fuzzy scale (Table 36). In the calculations in Table 38-39, Equations 4.1 to 4.4 were followed. The fuzzy evaluation matrix for respondent 1 is shown in Table 38.

Table 38: Fuzzy Evaluation Matrix for Respondent 1

ENVIRONMENTAL															
1	Comp - RF			Beh – RF			Man – RF			Mor – RF			Int - RF		
Comp - RF	1.00	1.00	1.00	0.13	0.14	0.17	0.17	0.20	0.25	2.00	3.00	4.00	4.00	5.00	6.00
Beh – RF	6.00	7.00	8.00	1.00	1.00	1.00	6.00	7.00	8.00	6.00	7.00	8.00	6.00	7.00	8.00
Man – RF	4.00	5.00	6.00	0.13	0.14	0.17	1.00	1.00	1.00	0.25	0.33	0.50	4.00	5.00	6.00
Mor – RF	0.25	0.33	0.50	0.13	0.14	0.17	2.00	3.00	4.00	1.00	1.00	1.00	6.00	7.00	8.00
Int - RF	0.17	0.20	0.25	0.13	0.14	0.17	0.17	0.20	0.25	0.13	0.14	0.17	1.00	1.00	1.00

SOCIAL															
1	Comp - RF			Beh – RF			Man – RF			Mor – RF			Int - RF		
Comp - RF	1.00	1.00	1.00	0.17	0.20	0.25	4.00	5.00	6.00	0.25	0.33	0.50	4.00	5.00	6.00
Beh – RF	4.00	5.00	6.00	1.00	1.00	1.00	6.00	7.00	8.00	2.00	3.00	4.00	6.00	7.00	8.00
Man – RF	0.17	0.20	0.25	0.13	0.14	0.17	1.00	1.00	1.00	0.25	0.33	0.50	4.00	5.00	6.00
Mor – RF	2.00	3.00	4.00	0.25	0.33	0.50	2.00	3.00	4.00	1.00	1.00	1.00	8.00	9.00	9.00
Int - RF	0.17	0.20	0.25	0.13	0.14	0.17	0.17	0.20	0.25	0.11	0.11	0.13	1.00	1.00	1.00

ECONOMIC															
1	Comp - RF			Beh – RF			Man – RF			Mor – RF			Int - RF		
Comp - RF	1.00	1.00	1.00	4.00	5.00	6.00	0.17	0.20	0.25	6.00	7.00	8.00	4.00	5.00	6.00
Beh – RF	0.17	0.20	0.25	1.00	1.00	1.00	0.17	0.20	0.25	4.00	5.00	6.00	2.00	3.00	4.00
Man – RF	4.00	5.00	6.00	4.00	5.00	6.00	1.00	1.00	1.00	6.00	7.00	8.00	6.00	7.00	8.00
Mor – RF	0.13	0.14	0.17	0.17	0.20	0.25	0.13	0.14	0.17	1.00	1.00	1.00	1.00	1.00	1.00
Int - RF	0.17	0.20	0.25	0.25	0.33	0.50	0.13	0.14	0.17	1.00	1.00	1.00	1.00	1.00	1.00

The fuzzy synthetic values for Respondent 1 are calculated and the results are shown in Table 39.

Table 39: Fuzzy Synthetic Values (S_{ij}) for Respondent 1

	S_{ij}_For Respondent 1								
	Environmental-Sustainability Related Hazards			Social-Sustainability Related Hazards			Economic-Sustainability Related Hazards		
Risk Factors	***l***	***m***	***u***	***l***	***m***	***u***	***l***	***m***	***u***
Competence Risk Factors	0.10	0.15	0.22	0.14	0.19	0.28	0.23	0.32	0.44
Behavioural Risk Factors	0.34	0.46	0.63	0.28	0.39	0.55	0.11	0.16	0.24
Managerial Risk Factors	0.13	0.18	0.26	0.08	0.11	0.16	0.31	0.43	0.60
Moral Risk Factors	0.13	0.18	0.26	0.19	0.28	0.38	0.04	0.04	0.05
Interconnectedness Risk Factors	0.02	0.03	0.03	0.02	0.03	0.04	0.04	0.05	0.06

A similar calculation is made for all twelve respondents, and the fuzzy weights of twelve respondents were combined through applying geometric mean (Çakır et al., 2009:50):

$$\overline{\widetilde{W}_i} = \left(\prod_{d=1}^{D} \widetilde{W}_i^d\right)^{\frac{1}{D}}, \forall d = 1, 2, \ldots, D \qquad \text{Equation 5.1}$$

Here, $\overline{\widetilde{W}_i}$ respresents the combined fuzzy weight of decision element i of D respondents, whereas W_i^k is the fuzzy weight of decision element i of respondent d and D illustrates the number of decision makers.

Table 40 showing the calculated values by Equation 5.1 is as follows:

Table 40: Geomean of Fuzzy Synthetic Values (S_{ij}) of Twelve Respondents

	GEOMEAN_S_{ij}_All Respondents								
	Environmental-Sustainability Related Hazards			Social-Sustainability Related Hazards			Economic-Sustainability Related Hazards		
Risk Factors	***l***	***m***	***u***	***l***	***m***	***u***	***l***	***m***	***u***
Competence Risk Factors	0.12	0.16	0.21	0.07	0.10	0.13	0.26	0.34	0.45
Behavioural Risk Factors	0.17	0.23	0.30	0.18	0.25	0.34	0.08	0.10	0.13
Managerial Risk Factors	0.13	0.18	0.25	0.15	0.21	0.28	0.24	0.32	0.43
Moral Risk Factors	0.12	0.16	0.21	0.17	0.23	0.30	0.04	0.05	0.07
Interconnectedness Risk Factors	0.06	0.08	0.11	0.05	0.07	0.09	0.07	0.09	0.11

In order to convert fuzzy numbers into crisp scores, Opricovic and Tzeng (2003)'s CFCS defuzzification method was employed by following the Equations 4.5 to 4.13. The tables showing the calculations are as follows (Table 41-46);

Table 41: CFCS Defuzzification Method_ $\Delta_{(max\text{-}min)}$ Calculation

	Environmental	**Social**	**Economic**
u_{max}	0.30	0.34	0.45
l_{min}	0.06	0.05	0.04
$\Delta_{(max\text{-}min)}$	0.24	0.28	0.41

Table 42: CFCS Defuzzification Method_ X_j crisp Calculation for Environmental Dimension

	Environmental-Sustainability Related Hazards					
Risk Factors	X_{lj}	X_{mj}	X_{uj}	X_{ls}	X_{us}	X_j **crisp**
Comp - RF	0,23	0,41	0,64	0,35	0,52	**0,42**
Beh – RF	0,45	0,69	1,00	0,56	0,76	**0,69**
Man – RF	0,29	0,50	0,81	0,41	0,62	**0,52**
Mor – RF	0,26	0,41	0,61	0,36	0,51	**0,43**
Int – RF	0,00	0,08	0,19	0,07	0,17	**0,09**

Table 43: CFCS Defuzzification Method_ X_j crisp Calculation for Social Dimension

	Social-Sustainability Related Hazards					
Risk Factors	X_{lj}	X_{mj}	X_{uj}	X_{ls}	X_{us}	X_j **crisp**
Comp – RF	0,04	0,14	0,28	0,13	0,25	**0,15**
Beh – RF	0,50	0,77	1,16	0,61	0,84	**0,76**
Man – RF	0,37	0,60	0,92	0,49	0,70	**0,61**
Mor – RF	0,45	0,68	1,00	0,55	0,76	**0,68**
Int – RF	0,00	0,05	0,13	0,05	0,12	**0,06**

Table 44: CFCS Defuzzification Method_ X_j crisp Calculation for Economic Dimension

	Economic-Sustainability Related Hazards					
Risk Factors	X_{lj}	X_{mj}	X_{uj}	X_{ls}	X_{us}	X_j **crisp**
Comp - RF	0,52	0,74	1,00	0,61	0,79	**0,73**
Beh – RF	0,08	0,14	0,22	0,13	0,20	**0,14**
Man – RF	0,48	0,68	0,95	0,57	0,75	**0,68**
Mor – RF	0,00	0,02	0,06	0,02	0,06	**0,03**
Int - RF	0,05	0,10	0,17	0,10	0,16	**0,11**

The crisp values for all alternatives of sustainability dimensions for the given criteria were then calculated as follows;

Table 45: CFCS Defuzzification Method_ Crisp Values

	Sustainability Related Hazards		
Risk Factors	**Envronmental** M_{ij}	**Social** M_{ij}	**Economic** M_{ij}
Comp. RF	0.16	0.10	0.34
Beh. RF	0.23	0.27	0.10
Man. RF	0.19	0.23	0.32
Mor. RF	0.16	0.25	0.06
Int. RF	0.08	0.07	0.09

Normalized crisp values, which show the final results, were then calculated as follows;

Table 46: CFCS Defuzzification Method_ Normalized Crisp Values

	Sustainability Related Hazards		
Risk Factors	**Envronmental M_{ij}-NORMALIZED**	**Social M_{ij}-NORMALIZED**	**Economic M_{ij}-NORMALIZED**
Comp. RF	0.20	0.11	0.38
Beh. RF	0.27	0.30	0.11
Man. RF	0.23	0.25	0.35
Mor. RF	0.20	0.27	0.06
Int. RF	0.10	0.08	0.10

The results of the fuzzy analysis provide the rankings shown in Table 47-48-49;

Table 47: Overall Ratings using Fuzzy AHP and CFCS Defuzzification Method for Environmental Dimension

Risk Factors	**Environmental Sustainability Related Hazards**	**Prioritization**
Behavioral Risk Factors	0,27	1
Managerial Risk Factors	0,23	2
Competence Risk Factors	0,20	3
Moral Risk Factors	0,20	4
Interconnectedness Risk Factors	0,10	5

Table 48: Overall Ratings using Fuzzy AHP and CFCS Defuzzification Method for Social Dimension

Risk Factors	Social Sustainability Related Hazards	Prioritization
Behavioral Risk Factors	0,30	1
Moral Risk Factors	0,27	2
Managerial Risk Factors	0,25	3
Competence Risk Factors	0,11	4
Interconnectedness Risk Factors	0,08	5

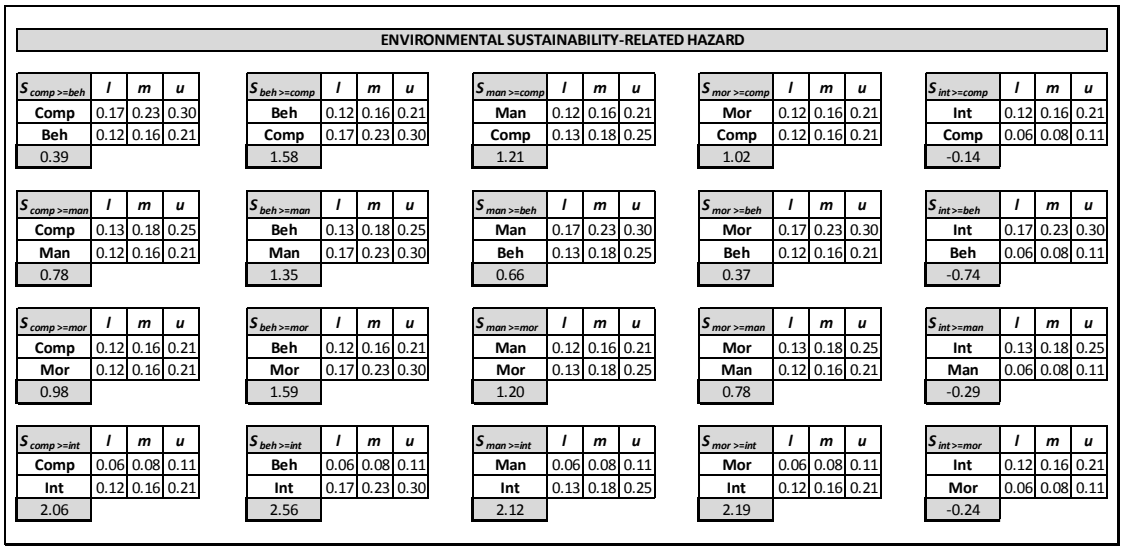
Table 49: Overall Ratings using Fuzzy AHP and CFCS Defuzzification Method for Economic Dimension

Risk Factors	Economic Sustainability Related Hazards	Prioritization
Competence Risk Factors	0,38	1
Managerial Risk Factors	0,35	2
Behavioral Risk Factors	0,11	3
Interconnectedness Risk Factors	0,10	4
Moral Risk Factors	0,06	5

5.4.3. Extent Analysis of Fuzzy AHP

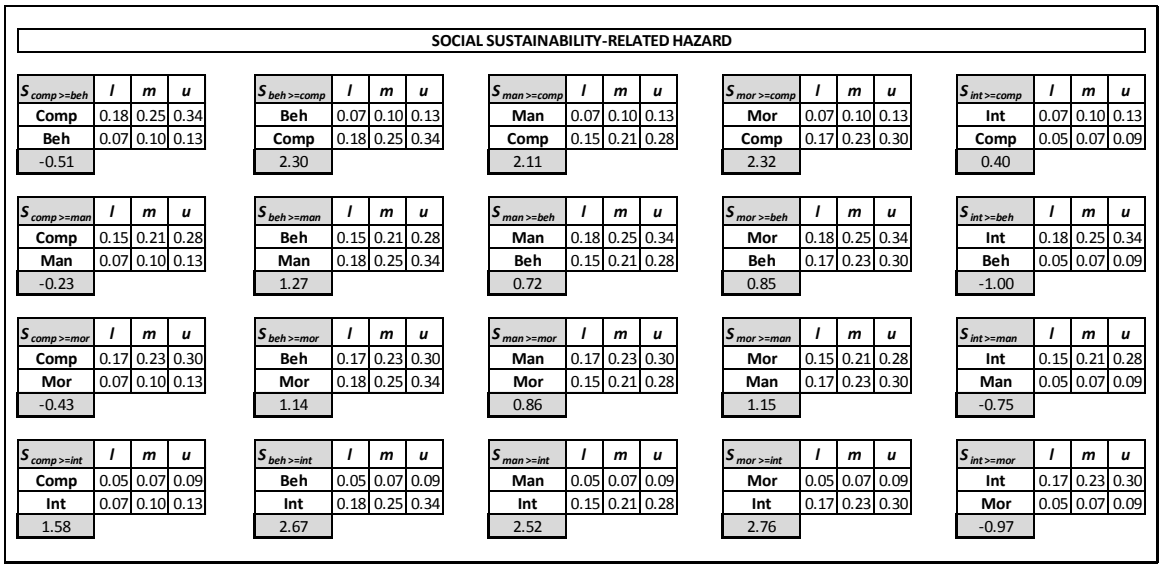
Another methodology that would be employed for ranking the criteria is extent analysis of fuzzy AHP proposed by Chang (1996). In this study, same analysis was made by extent fuzzy AHP by following the Equations 14-21, in order to compare and validate the results of the two different methodologies. The table showing the fuzzy synthetic values for the geomean of twelve experts for each dimension (Tables 50-51-52) is taken into analysis as follows;

Table 50: Extent Analysis of Fuzzy AHP for Environmental Sustainability-Related Hazards



ENVIRONMENTAL SUSTAINABILITY-RELATED HAZARD																				
$S_{comp>=beh}$	*l*	*m*	*u*	$S_{beh>=comp}$	*l*	*m*	*u*	$S_{man>=comp}$	*l*	*m*	*u*	$S_{mor>=comp}$	*l*	*m*	*u*	$S_{int>=comp}$	*l*	*m*	*u*
Comp	0.17	0.23	0.30	Beh	0.12	0.16	0.21	Man	0.12	0.16	0.21	Mor	0.12	0.16	0.21	Int	0.12	0.16	0.21
Beh	0.12	0.16	0.21	Comp	0.17	0.23	0.30	Comp	0.13	0.18	0.25	Comp	0.12	0.16	0.21	Comp	0.06	0.08	0.11
0.39				1.58				1.21				1.02				-0.14			
$S_{comp>=man}$	*l*	*m*	*u*	$S_{beh>=man}$	*l*	*m*	*u*	$S_{man>=beh}$	*l*	*m*	*u*	$S_{mor>=beh}$	*l*	*m*	*u*	$S_{int>=beh}$	*l*	*m*	*u*
Comp	0.13	0.18	0.25	Beh	0.13	0.18	0.25	Man	0.17	0.23	0.30	Mor	0.17	0.23	0.30	Int	0.17	0.23	0.30
Man	0.12	0.16	0.21	Man	0.17	0.23	0.30	Beh	0.13	0.18	0.25	Beh	0.12	0.16	0.21	Beh	0.06	0.08	0.11
0.78				1.35				0.66				0.37				-0.74			
$S_{comp>=mor}$	*l*	*m*	*u*	$S_{beh>=mor}$	*l*	*m*	*u*	$S_{man>=mor}$	*l*	*m*	*u*	$S_{mor>=man}$	*l*	*m*	*u*	$S_{int>=man}$	*l*	*m*	*u*
Comp	0.12	0.16	0.21	Beh	0.12	0.16	0.21	Man	0.12	0.16	0.21	Mor	0.13	0.18	0.25	Int	0.13	0.18	0.25
Mor	0.12	0.16	0.21	Mor	0.17	0.23	0.30	Mor	0.13	0.18	0.25	Man	0.12	0.16	0.21	Man	0.06	0.08	0.11
0.98				1.59				1.20				0.78				-0.29			
$S_{comp>=int}$	*l*	*m*	*u*	$S_{beh>=int}$	*l*	*m*	*u*	$S_{man>=int}$	*l*	*m*	*u*	$S_{mor>=int}$	*l*	*m*	*u*	$S_{int>=mor}$	*l*	*m*	*u*
Comp	0.06	0.08	0.11	Beh	0.06	0.08	0.11	Man	0.06	0.08	0.11	Mor	0.06	0.08	0.11	Int	0.12	0.16	0.21
Int	0.12	0.16	0.21	Int	0.17	0.23	0.30	Int	0.13	0.18	0.25	Int	0.12	0.16	0.21	Mor	0.06	0.08	0.11
2.06				2.56				2.12				2.19				-0.24			

Table 51: Extent Analysis of Fuzzy AHP for Social Sustainability-Related Hazards



SOCIAL SUSTAINABILITY-RELATED HAZARD																				
$S_{comp>=beh}$	*l*	*m*	*u*	$S_{beh>=comp}$	*l*	*m*	*u*	$S_{man>=comp}$	*l*	*m*	*u*	$S_{mor>=comp}$	*l*	*m*	*u*	$S_{int>=comp}$	*l*	*m*	*u*
Comp	0.18	0.25	0.34	Beh	0.07	0.10	0.13	Man	0.07	0.10	0.13	Mor	0.07	0.10	0.13	Int	0.07	0.10	0.13
Beh	0.07	0.10	0.13	Comp	0.18	0.25	0.34	Comp	0.15	0.21	0.28	Comp	0.17	0.23	0.30	Comp	0.05	0.07	0.09
-0.51				2.30				2.11				2.32				0.40			
$S_{comp>=man}$	*l*	*m*	*u*	$S_{beh>=man}$	*l*	*m*	*u*	$S_{man>=beh}$	*l*	*m*	*u*	$S_{mor>=beh}$	*l*	*m*	*u*	$S_{int>=beh}$	*l*	*m*	*u*
Comp	0.15	0.21	0.28	Beh	0.15	0.21	0.28	Man	0.18	0.25	0.34	Mor	0.18	0.25	0.34	Int	0.18	0.25	0.34
Man	0.07	0.10	0.13	Man	0.18	0.25	0.34	Beh	0.15	0.21	0.28	Beh	0.17	0.23	0.30	Beh	0.05	0.07	0.09
-0.23				1.27				0.72				0.85				-1.00			
$S_{comp>=mor}$	*l*	*m*	*u*	$S_{beh>=mor}$	*l*	*m*	*u*	$S_{man>=mor}$	*l*	*m*	*u*	$S_{mor>=man}$	*l*	*m*	*u*	$S_{int>=man}$	*l*	*m*	*u*
Comp	0.17	0.23	0.30	Beh	0.17	0.23	0.30	Man	0.17	0.23	0.30	Mor	0.15	0.21	0.28	Int	0.15	0.21	0.28
Mor	0.07	0.10	0.13	Mor	0.18	0.25	0.34	Mor	0.15	0.21	0.28	Man	0.17	0.23	0.30	Man	0.05	0.07	0.09
-0.43				1.14				0.86				1.15				-0.75			
$S_{comp>=int}$	*l*	*m*	*u*	$S_{beh>=int}$	*l*	*m*	*u*	$S_{man>=int}$	*l*	*m*	*u*	$S_{mor>=int}$	*l*	*m*	*u*	$S_{int>=mor}$	*l*	*m*	*u*
Comp	0.05	0.07	0.09	Beh	0.05	0.07	0.09	Man	0.05	0.07	0.09	Mor	0.05	0.07	0.09	Int	0.17	0.23	0.30
Int	0.07	0.10	0.13	Int	0.18	0.25	0.34	Int	0.15	0.21	0.28	Int	0.17	0.23	0.30	Mor	0.05	0.07	0.09
1.58				2.67				2.52				2.76				-0.97			

Table 52: Extent Analysis of Fuzzy AHP for Economic Sustainability-Related Hazards

ECONOMIC SUSTAINABILITY-RELATED HAZARD

$S_{comp>=beh}$	*l*	*m*	*u*
Comp	0.08	0.10	0.13
Beh	0.26	0.34	0.45
2.89			

$S_{beh>=comp}$	*l*	*m*	*u*
Beh	0.26	0.34	0.45
Comp	0.08	0.10	0.13
-1.04			

$S_{man>=comp}$	*l*	*m*	*u*
Man	0.26	0.34	0.45
Comp	0.24	0.32	0.43
0.88			

$S_{mor>=comp}$	*l*	*m*	*u*
Mor	0.26	0.34	0.45
Comp	0.04	0.05	0.07
-1.84			

$S_{int>=comp}$	*l*	*m*	*u*
Int	0.26	0.34	0.45
Comp	0.07	0.09	0.11
-1.24			

$S_{comp>=man}$	*l*	*m*	*u*
Comp	0.24	0.32	0.43
Man	0.26	0.34	0.45
1.12			

$S_{beh>=man}$	*l*	*m*	*u*
Beh	0.24	0.32	0.43
Man	0.08	0.10	0.13
-0.93			

$S_{man>=beh}$	*l*	*m*	*u*
Man	0.08	0.10	0.13
Beh	0.24	0.32	0.43
2.67			

$S_{mor>=beh}$	*l*	*m*	*u*
Mor	0.08	0.10	0.13
Beh	0.04	0.05	0.07
-0.19			

$S_{int>=beh}$	*l*	*m*	*u*
Int	0.08	0.10	0.13
Beh	0.07	0.09	0.11
0.71			

$S_{comp>=mor}$	*l*	*m*	*u*
Comp	0.04	0.05	0.07
Mor	0.26	0.34	0.45
3.48			

$S_{beh>=mor}$	*l*	*m*	*u*
Beh	0.04	0.05	0.07
Mor	0.08	0.10	0.13
2.06			

$S_{man>=mor}$	*l*	*m*	*u*
Man	0.04	0.05	0.07
Mor	0.24	0.32	0.43
3.22			

$S_{mor>=man}$	*l*	*m*	*u*
Mor	0.24	0.32	0.43
Man	0.04	0.05	0.07
-1.76			

$S_{int>=man}$	*l*	*m*	*u*
Int	0.24	0.32	0.43
Man	0.07	0.09	0.11
-1.14			

$S_{comp>=int}$	*l*	*m*	*u*
Comp	0.07	0.09	0.11
Int	0.26	0.34	0.45
3.05			

$S_{beh>=int}$	*l*	*m*	*u*
Beh	0.07	0.09	0.11
Int	0.08	0.10	0.13
1.28			

$S_{man>=int}$	*l*	*m*	*u*
Man	0.07	0.09	0.11
Int	0.24	0.32	0.43
2.82			

$S_{mor>=int}$	*l*	*m*	*u*
Mor	0.07	0.09	0.11
Int	0.04	0.05	0.07
0.12			

$S_{int>=mor}$	*l*	*m*	*u*
Int	0.04	0.05	0.07
Mor	0.07	0.09	0.11
1.79			

Then, the calculations were made accordingly;

Table 53: Calculation for min $V\ S_i \geq S_z$

ENVIRONMENTAL_$d'(A_i)$					
					$d'(A_i)$
Comp	0.39	0.78	0.98	1.00	**0.39**
Beh	1.00	1.00	1.00	1.00	**1.00**
Man	1.00	0.66	1.00	1.00	**0.66**
Mor	1.00	0.37	0.78	1.00	**0.37**
Int	0.00	0.00	0.00	0.00	**0.00**

SOCIAL_$d'(A_i)$					
					$d'(A_i)$
Comp	0.00	0.00	0.00	1.00	**0.00**
Beh	1.00	1.00	1.00	1.00	**1.00**
Man	1.00	0.72	0.86	1.00	**0.72**
Mor	1.00	0.85	1.00	1.00	**0.85**
Int	0.40	0.00	0.00	0.00	**0.00**

ECONOMIC_$d'(A_i)$					
					$d'(A_i)$
Comp	1.00	1.00	1.00	1.00	**1.00**
Beh	0.00	0.00	1.00	1.00	**0.00**
Man	0.88	1.00	1.00	1.00	**0.88**
Mor	0.00	0.00	0.00	0.12	**0.00**
Int	0.00	0.71	0.00	1.00	**0.00**

Using these vectors; weigth vectors, W', and normalized weight vectors, W, for all alternatives were calculated as follows (Table 54):

Table 54: Calculation of Weight Vectors and Normalized Weight Vectors

	Environmental		**Social**		**Economic**	
	W'	W	W'	W	W'	W
Comp	0.39	**0.16**	0.00	**0.00**	1.00	**0.53**
Beh	1.00	**0.41**	1.00	**0.39**	0.00	**0.00**
Man	0.66	**0.27**	0.72	**0.28**	0.88	**0.47**
Mor	0.37	**0.15**	0.85	**0.33**	0.00	**0.00**
Int	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**

The summary tables showing the fuzzy extent analysis calculations for three dimensions of sustainability are as follows (Table 55-56-57);

Table 55: Overall Ratings using extent analysis of Fuzzy AHP for Environmental Dimension

Risk Factors	Environmental Sustainability Related Hazards	Prioritization
Behavioral Risk Factors	0,41	1
Managerial Risk Factors	0,27	2
Competence Risk Factors	0,16	3
Moral Risk Factors	0,15	4
Interconnectedness Risk Factors	0,00	5

Table 56: Overall Ratings using extent analysis of Fuzzy AHP for Social Dimension

Risk Factors	Social Sustainability Related Hazards	Prioritization
Behavioral Risk Factors	0,39	1
Moral Risk Factors	0,33	2
Managerial Risk Factors	0,28	3
Competence Risk Factors	0,00	4
Interconnectedness Risk Factors	0,00	5

Table 57: Overall Ratings using extent analysis of Fuzzy AHP for Economic Dimension

Risk Factors	Economic Sustainability Related Hazards	Prioritization
Competence Risk Factors	0,53	1
Managerial Risk Factors	0,47	2
Behavioral Risk Factors	0,00	3
Interconnectedness Risk Factors	0,00	4
Moral Risk Factors	0,00	5

5.4.4. Comparing the Results of Fuzzy AHP and Extent Analysis of Fuzzy AHP

In order to compare and identify whether the outputs of the two methods (fuzzy AHP and extent fuzzy AHP) result in different rankings, a table showing the overall ratings of the two methodologies were prepared for different dimensions of sustainability in Tables 58-59-60:

Table 58: Overall ratings using Fuzzy AHP and Extent Fuzzy AHP for Environmental Sustainability-Related Hazards

	Environmental Sustainability Related Hazards		
Risk Factors	**Fuzzy AHP**	**Extent Fuzzy AHP**	**Prioritization**
Behavioral Risk Factors	0.27	0.41	**1**
Managerial Risk Factors	0.23	0.27	**2**
Competence Risk Factors	0.20	0.16	**3**
Moral Risk Factors	0.20	0.15	**4**
Interconnectedness Risk Factors	0.10	0.00	**5**

Table 59: Overall ratings using Fuzzy AHP and Extent Fuzzy AHP for Social Sustainability-Related Hazards

	Social Sustainability Related Hazards		
Risk Factors	**Fuzzy AHP**	**Extent Fuzzy AHP**	**Prioritization**
Behavioral Risk Factors	0.30	0.39	**1**
Moral Risk Factors	0.27	0.33	**2**
Managerial Risk Factors	0.25	0.28	**3**
Competence Risk Factors	0.11	0.00	**4**
Interconnectedness Risk Factors	0.08	0.00	**5**

Table 60: Overall ratings using Fuzzy AHP and Extent Fuzzy AHP for Economic Sustainability-Related Hazards:

	Economic Sustainability Related Hazards		
Risk Factors	**Fuzzy AHP**	**Extent Fuzzy AHP**	**Prioritization**
Competence Risk Factors	0.38	0.53	**1**
Managerial Risk Factors	0.35	0.47	**2**
Behavioral Risk Factors	0.11	0.00	**3**
Interconnectedness Risk Factors	0.10	0.00	**4**
Moral Risk Factors	0.06	0.00	**5**

5.4.5. Consistency Check of Fuzzy AHP Matrix

In order to verify the consistency of the entire AHP, pairwise comparisons for each of the individual criterion matrices for different alternatives need to be evaluated. Therefore, before the evaluations of the performance of each element are discussed, the consistency check on subjective evaluations was made (Table 61).

Table 61: Consistency Ratio for the criteria of Environmental, Social and Economic Dimensions

	Environmental	**Social**	**Economic**
δ_{max}	5.165	5.081	5.150
Consistency Index	0.041	0.020	0.038
Consistency Ratio	0.037	0.018	0.034
Decision	**accept**	**accept**	**accept**

Since CR < 0.1, **accept** the pairwise comparion matrices for all three dimensions

Since the resulting CR ratio is less than 0.1, the pairwise comparison matrices are accepted (Saaty, 1980; Haq and Kannan, 2006).

The results are then discussed accordingly.

5.4.6. The Evaluation of Findings of Fuzzy AHP Analysis in Food Supply Chain

In this analysis, the relative importance of risk factors were identified in terms of each individual dimension, namely, environmental, social and economic, of sustainability-related hazards, and the results were compared in order to identify whether their relative importance varies for any of the dimensions. Therefore, the results address to the sixth research question. This is also the part, where sustainability orientation on supply chain risk factors, were developed, and main discussions were built.

The overall ratings by using fuzzy AHP, and extent analysis of fuzzy AHP for all three dimensions of sustainability address similar rankings for the given criteria of five risk factors. However, the results show that the relative importance of those risk factors differ in terms of their impacts on economic, environmental and social sustainability-related hazards.

In the environmental and social dimension, behavioral risk factors are ranked first, with a greater impact, whereas in economic dimension competence risk factors took the first place in ranking. Considering that behavioral risk factors arise mainly due to complacency, consciousness, perception, labor behavior or reputation related risk factors, this finding indicates that the major focus should be on managing behavioral risk factors in order to avoid environmental and social sustainability-related hazards.

On the other hand, competence risk factors, which are mainly caused by capability, quality, resource, traceability and information related-risk factors, would need to be managed in order to avoid an economic sustainability-related hazard. Competence risk factors are ranked third in environmental dimension, but fourth in social dimension. Besides, behavioral risk factors are ranked third in economic dimension, which is far different from the situation in the environmental and social dimensions. In economic sustainability dimension, competence risk factors are followed by managerial risk factors, caused mainly by control, governance, legal,

planning, inertia, health and safety, and self-focus related risk factors. Managerial risk factors are ranked as the second most important criteria in terms of impact on environmental sustainability-related hazards, whereas third in social.

The results show that social sustainability-related hazards are triggered, first by behavioral risk factors, and second by moral risk factors, due to ethics or opportunism risk-related factors. However, moral risk factors are ranked as the least important criteria in economic sustainability-related hazards, and fourth in environmental sustainability-related hazards, which is again very different from its ranking in social dimension. Among all five risk factors, interconnectedness risk factor, caused by structural, stakeholder, seasonality and dependence related-risk factors, are ranked as the least important in environmental and social dimension, while fourth in economic dimension. Therefore, the results of the analysis show that, different dimensions of sustainability require a focus on avoiding different risk factors.

This states that, one strategy for supply chain risk management is implemented to avoid economic sustainability-related hazards would not avoid social or environmental sustainability-related hazards, or vice versa. Considering that, in supply chains, risk-oriented framework needs to be developed to avoid risks in all three dimensions of sustainability (Seuring and Müller, 2008), approaching risk factors, which are primarily important for all three dimensions of sustainability, would avoid potential serious losses. In this case, a sustainability-oriented supply chain risk management framework can be developed, which first prevents behavioral and competence risk factors, and then prevents managerial and moral risk factors.

5.5. THE FRAMEWORK FOR SUSTAINABILITY-ORIENTED RISK MANAGEMENT IN FOOD SUPPLY CHAINS

In this study, supply chain risk management is approached from a sustainability framework and a theoretical methodology is proposed to develop sustainability orientation to supply chain risk management strategies. The methodological steps were adapted to the focusing steps of TOC, which first starts by identifying the risk factors for all related supply chain members from a sustainability

framework, then assessing and outlining the most frequently mentioned risk factors in common. Here, the most critical point is to involve all related supply chain members in the risk identification and assessment process, and to identify the commonly cited risk factors which touch upon any dimension of sustainability-related hazards.

Besides, the mitigation strategies mentioned most frequently by supply chain members in general were also identified, in order to recommend for a shared risk plan which is accepted by all related members. The sustainability orientation is developed on risk management strategies by assessing the relative importance of those risk factors with respect to each individual dimensions of sustainability. This helps to identify the urgent risk factors to be managed, in order to mitigate their impacts on the three dimensions of sustainability-related hazards from an integrated perspective. As offered by TOC, this process requires a continuous assessment to maintain and ensure supply chain wide risk management.

In this study, this approach is implemented in food supply chains, and the risk factors were identified by conducting a multiple-case study within different types of food product supply chains. The interviews and observations were carried out with different supply chain members for each food supply chain. The content analysis methodology was used to code the latent meanings of risk factors discussed, and the results were analyzed using within and cross case analysis to identify the risk factors addressed in each type of food supply chain, and determine whether those risk factors differ across food supply chain types. Here, twenty three identified risk factors were grouped into five categories. The analysis of case data outlined that the rankings of emphasis of risk factors are similar at each food product supply chain type, whereas a discrete pattern across different food supply chains does not exist in terms of their emphasis on different risk factors. The emphasis at each food product supply chain type mostly addresses to behavioral risk factors, caused especially by consciousness related issues. Managerial risk factors caused especially by control and health and safety related issues, and competence risk factors with similar emphasis of risk factors, follow respectively. Here, the emphasis on opportunism risk factors in moral risk factor group is also noticeable. On the other hand, interconnectedness risk factors were referred by a minority.

The following analysis, which models the contextual relationships and interactions across the risk factors by ISM methodology, highlights that the ground root cause of all risk factors is behavioral risk factors. This model further supports the findings of multiple-case analysis, indicating that the emphasis should be given on mitigating behavioral aspects, which would also alleviate other groups of risk factors related to competence, managerial, moral and interconnectedness.

Furthermore, the relative importance of those risk factors were then evaluated in terms of their impacts on economic, social and environmental sustainability-related hazards through fuzzy AHP, and the urgent risk factors were explored in order to prevent sustainability-related hazards from an integrated perspective. The results of this analysis show that the relative importance of those risk factors differs in terms of their impacts on economic, environmental and social sustainability-related hazards. Behavioral risk factors have a greater impact on environmental and social sustainability-related hazards, whereas competence risk factors rank highest in economic sustainability-related hazards.

The comprehensive evaluation of the results of the theoretical methodology (Figure 7) indicated that sustainability-oriented food supply chain risk management requires the avoidance of behavioral risk factors by all related supply chain members, with a specific attention on the consciousness-related risk factor. This was followed by competence and managerial risk factors. The management of moral risk factors was also considered to be important, with a specific emphasis on opportunism risk factors, whereas interconnectedness risk factors could be given less attention.

From the theoretical framework of this study, which was based on the perspectives on TOC and chaos theory, it is possible to state that behavioral risk factors are the common causes of sustainability-related hazards for all three dimensions (economic, environmental, social), and therefore can be referred as the core conflict or the underlying mechanism to limit the performance of the system to achieve to its TBL-oriented goal in food supply chains.

CHAPTER VI
CONCLUSION

6.1. GENERAL DISCUSSION AND THEORETICAL CONTRIBUTIONS

Supply chains are value-creating networks which work together to create customer value (Kothandaraman and Wilson, 2001; Lusch, Vargo and Tanniru, 2010). Supply chains, if managed to achieve increased integration among the network of business relationships, provide opportunities for improving the long run continuity and competitiveness of a business (Lambert, Cooper and Pagh, 1998; Mentzer et al., 2001), particularly when companies are faced with the increased complexity and dynamism of business environments due to increased globalization, increased demands of customers, performance-based competition or cost concerns (Mentzer et al., 2001). Therefore, in a search for improved competitiveness, companies are increasingly concerned about the sensitivities associated with their sustainability and risk management performances for ensuring global success and survival, not only within their own operational arena, but also throughout the whole supply chains of which they are a part. This requires a focus on social and environmental performances, rather than following a purely economic focus, as well as avoidance of risks associated with all three dimensions comprehensively (Seuring and Müller, 2008; Rao and Goldsby, 2009). This has triggered the need for an additional attention on the studies which examines sustainability traces in risk management, with the complete involvement of supply chain members (Hassini, Surti and Searcy, 2012; Hoffmann et al., 2013), especially for diversified industries (Jüttner, 2005; Olson and Wu, 2010; Rajurkar and Jain, 2011; Singhal, Agarwal and Mittal, 2011), including also the consumers (Houghton et al., 2006; Houghton et al., 2008; Olsson and Skjöldebrand, 2008; Von Kanel et al., 2010). Consumers, as important members of supply chains, are necessarily required to be involved in studies, to reflect their perceptions and create sustained value (Olsson and Skjöldebrand, 2008). This scope of the unit of analysis has been defined as the *supply chain* in this research, the importance of which has been emphasized in the literature (Carter and Easton, 2011). Such an approach also provided the collection of

rich data and enabled comprehensive, broader and deeper understanding on the issues discussed.

This study refers to the arguments regarding the gaps mentioned in the literature (refer to Figure 1), and aims to develop a sustainability framework on supply chain risk management strategies, by relying on the theoretical focus provided by supply chains, risk management and sustainability literature. Following this aim, an approach to assessing the sustainability orientation in supply chain risk management strategies is proposed, which is presented through an implementation on food industry. This approach is formulated by the theoretical lens mainly provided by TOC and chaos theory, and involves multiple methodologies, both qualitative and quantitative. Besides, despite its clear relevance, the contribution of chaos theory in marketing systems has been seriously neglected in the marketing literature (Hibbert and Wilkinson, 1994), which is further referred by the theoretical framework of this study. Therefore, it is important to mention here that the major contribution of this thesis lies in its fundamental context, which aims to address these gaps while developing a sustainability orientation to risk management strategies of supply chains from a TBL perspective.

Within this perspective, the theoretical background of the study is developed by utilizing the main concepts of TOC. The approach is further supported by the propositions of chaos theory, to provide for a methodological path to follow and develop a sustainability orientation on risk management in supply chains with a TBL approach. This attempt to revalue the fundamental assumptions and propositions of those existing theories from a sustainability and risk framework allows this theory to be applied to new areas, and can therefore be considered as an extension of TOC. The arguments provided to better of the structure of these theories by incorporating the recent attentions of the academy and the industry could be considered as one important theoretical contribution of this study.

Another theoretic perspective is provided while addressing **Research Question 1**, to offer for a generic approach to identify supply chain risk factors. The constraint propositions argued by the theories are assessed which would explain the supply chain risks from a more generic perspective. Within this framework, some frequently referred theories, which primarily were identified to be referring to the

theoretical focus provided by the literature on supply chains, risk management and sustainability, are reviewed, namely, Agency Theory, Institutional Theory, Stakeholder Theory, Contingency Theory, Resource Based View, Dynamic Capabilities, Natural Resource Based View, Resource Dependence Theory, Population Ecology, and Transaction Cost Economics. As a result, risk factors were identified related to self-interest, organizational heterogeneity, immorality, organizational rigidity, resource similarity, resource stability, environmental negligence, interdependency, inertia and non-governance of exchange relationships. These generic risk factors were then related with the risk factors identified within the study, and discussions were provided accordingly. This argument offers a theoretical approach to identifying supply chain risks from a generic perspective, which also contributes to the literature emphasizing the need for increased attention on risk identification phase (Rao and Goldsby, 2009).

In this study, a sustainability framework on supply chain risk management strategies is developed by proposing a theoretical methodology built on TOC and chaos theory, which present the steps of an approach to assess the sustainability orientation in supply chain risk management strategies. This theoretical methodology starts with the identification of risk factors throughout the entire supply chain from a TBL perspective, and an assessment of the risk factors commonly and most frequently mentioned by the members in general. A TBL perspective is incorporated into the approach by first discussing the nodes of sustainability in logistics operations from all three dimensions, and later by eliciting the risk factors which might potentially cause sustainability-related hazards. Here, it is also critically important to outline the interactions across risk factors, and identify the core causes, if any. This is followed by outlining the mitigation strategies commonly highlighted by supply chain members, in order to plan for coordinated action in managing supply chain risks in general. The explicit sustainability orientation is developed to supply chains risk factors, while the relative importance of each risk factor is assessed in terms of their impacts on economic, social and environmental sustainability-related hazards. Consequently, the findings at each step are reviewed, and a comprehensive evaluation is made to recommend a strategy to develop sustainability-orientation in supply chain risk management. This theoretical methodology, based on TOC and

chaos theory, addresses the aim of this study by presenting the main framework of the path towards sustainability-oriented supply chain risk management, and thus could be considered as the fundamental contribution of this thesis.

This theoretical methodology is implemented on food supply chains in the research part of this study, and multiple methodological steps are proposed to follow while developing sustainability orientation to food supply chain risk management strategies. Selecting food supply chains as the sample industry also contributed to industry-specific research related to risk and sustainability (Carter and Easton, 2011; Singhal, Agarwal and Mittal, 2011; Hassini, Surti and Searcy, 2012), due to the sensitivity of logistics processes, and to rapidly increasing concerns on the continuous change in the quality of raw materials during the logistics processes (Rajurkar and Jain, 2011), which also provided a rich discussion on the research questions.

As proposed by the theoretical methodology in Figure 7, the methodological steps start with the identification of risk factors in the logistics operations of food supply chains from a TBL perspective through a multiple-case study, conducted within five different types of food supply chains, namely, meat, chicken, dairy products, fish and retail food. This was necessarily important to outline and consider different viewpoints of multiple supply chain members from different levels, and different food supply chain types, through the interviews and observations made at various sites. Multi-case studies also help to understand whether the phenomenon under examination performs differently in different environments (Stake, 2006). In total, forty one semi-structured interviews were conducted, and twenty eight observations were made at thirty two companies, resulting in very rich data collection. The latent meanings of the qualitative data were coded through latent content analysis into twenty three risk factors, which were then grouped into five risk factor groups, all of which were further validated through inter-coder reliability by three academicians in the field, with 95% success. This coding clarifies the **Research Question 2**, in which the risk factors in logistics operations of food supply chains from a TBL perspective were questioned. As a result, the risk factors of complacency, consciousness, labor, perception and reputation were grouped as behavioral risk factors; the risk factors of capability, information, quality, resource and traceability

were grouped as competence risk factors; the risk factors of control, governance, inertia, legality, health and safety, self-focus and planning were grouped as managerial risk factors; the risk factors of structural, seasonality, stakeholder and dependence were grouped as interconnectedness risk factors; and the risk factors of ethics and opportunism were grouped as moral risk factors. The exploration of twenty-three risk factors in food supply chains and their grouping into five risk factors is a novel approach, and therefore, could be considered as another important contribution provided by this thesis.

Besides, although these coding of the latent meanings were verified by the review of the literature, they were further reviewed through manifest content analysis across 488 articles downloaded from *web of knowledge* database with *risk* in title and *supply chain* or *logistics* in topic, and analyzed through the use of NVivo software, in order to outline whether those risk factors were addressed in the literature and in which frequency. Through this analysis, it was revealed that the literature is scarce on consciousness, self-focus, ethics, and opportunism risk factors, whereas complacency and inertia risk factors were not addressed at all. Therefore, exploring the reasons for the lack of research focus on these risk factors in food supply chains can be considered as another important contribution of the multiple-case study conducted in this thesis.

The multiple case study data were further analyzed using within and cross case analysis, in order to outline the risk factors addressed at each type of food supply chain, and identify if the risk factors differ across different food supply chain types. The results of the within case analysis clarify **Research Question 3**, and indicate that almost all risk factors were similarly mentioned at each food product supply chain type, mostly addressing behavioral risk factors, caused especially by consciousness related issues. This is followed by managerial risk factors caused especially by control and health and safety related issues, and competence risk factors, with similar emphasis of related risk factors. On the other hand, although moral risk factor group is not mentioned commonly as the others, the frequency of emphasis on opportunism risk factor is also noticeable. On the other hand, interconnectedness risk factor group was referred by a minority. This conclusion indicates a strong need to focus on behavioral aspects, notably the consciousness risk

factors, when building risk management strategies in food supply chains within a TBL framework. Furthermore, cross case analysis addresses **Research Question 4** and indicates that a discrete pattern across different food supply chains does not exist in terms of their emphasis on different risk factors. This might be because food products are all temperature-sensitive, shelf life constrained and perishable in nature (Rajurkar and Jain, 2011), thus creating similar risk factors for all types of food products.

In order to identify the core cause of risk factors, it was also necessary to examine the contextual relationships and interactions across the risk factors. This analysis, also addressing **Research Question 5**, was made by utilizing ISM methodology. The results supported the conclusion outlined by the multiple case study analysis, and indicated that behavioral risk factors were the core cause of risks in food supply chains, and the mitigation of these factors would benefit other groups of risk factors related to competence, managerial, moral and interconnectedness.

Following these arguments, twelve of the respondents selected as providing the best performance interviews in multiple-case study, were required to make pairwise comparisons of the relative importance of risk factor groups, based on their impact on environmental, social and economic sustainability-related hazards distinctively, by utilizing the methodological perspective provided by the Fuzzy AHP. In order to compare and validate the results of the two different approaches in Fuzzy AHP, the results were analyzed first by fuzzy AHP, which is employed by Opricovic and Tzeng (2003)'s CFCS defuzzification method, and then by Chang (1996)'s extent analysis of Fuzzy AHP. This analysis is where the main sustainability orientation is developed on food supply chain risk factors, and thus the findings here address **Research Question 6**. The rankings of the two fuzzy AHP analyses support each other. The results show that the relative importance of those risk factors differ in terms of their impacts on economic, environmental and social sustainability-related hazards, where behavioral risk factors ranked first on environmental and social dimension, whereas competence risk factors took the first place in economic dimension. On the other hand, managerial risk factors were ranked second in environmental and economic dimensions, while in social dimension behavioral risk factors were followed by moral risk factors. It has been outlined that different

dimensions of sustainability require a focus on the prevention of different risk factors. This states that preventing risk factors related to economic sustainability-related hazards might not avoid social or environmental sustainability-related hazards, or vice versa; and thus fail to prevent potential serious losses. Therefore, an integrated focus should be given on avoiding the risk factors that were ranked high in all three dimensions, which, in this case, addresses first the prevention of behavioral and competence risk factors, followed by managerial and moral risk factors.

By referring to the above findings and evaluating the discussions in common, **Research Question 7** can be clarified, which questions the path towards developing sustainability-oriented risk management framework in food supply chains by following the theoretical methodology proposed in Figure 7, within this perspective. This integrated evaluation of the results of multiple methodologies employed indicated that sustainability-oriented food supply chain risk management requires the avoidance of behavioral risk factors in all related supply chain members, with a specific attention to consciousness-related risk factor. This was identified as the core risk factor in almost every analysis, and therefore it is important to prevent it. The aforementioned emphasis in the literature on the shift towards non-quantifiable factors in food supply chains, mostly the behavioral ones, related to trust, culture, power, relationship or power (Rajurkar and Jain, 2011), also support the concluding argument of this study. Therefore, behavioral risk factors were also mentioned in the literature to be seriously prevented (Rodgers, 2011). Behavioral risk factors were followed by competence and managerial risk factors, as well as moral risk factors, with a specific emphasis on opportunism risk factors, whereas interconnectedness risk factors were less strongly emphasized. Especially, the cost concerns of supply chain partners leading to opportunistic behaviors are also mentioned in the literature as an important threat to be considered (Roth et al., 2008; Prentice and McLachlin, 2010).

Considering that factors related to facilities, human skills, culture, experiences, managerial commitment are mentioned as barriers to sustainability in upstream supply chains (Ageron, Gunasekaran and Spalanzani, 2012), in addition to the role of behavioral factors, it was highlighted that personality traits and experience should be incorporated in risk management models (Singhal, Agarwal and Mittal,

2001). This conclusion provides additional insights to further studies, with its main emphasis on the necessity of preventing behavioral risk factors, mainly driven by consciousness risk factors, as well as other complacency, perception, labor or reputation related factors, in order to ensure sustainability-oriented risk management in food chains. Constraints in food industry is analyzed from a TOC framework beforehand through case studies and constraints, such as market nature, scale and nature of products, employment and skills, institutional factors, supply chain relationships, certification, policy and regulatory issues, and personal beliefs and anthropomorphism, are identified for small local food chains (Oglethorpe and Heron, 2013). Here, the need for further research to reveal the different dynamics inherent in the food industry is proposed in order to enhance agility and competitiveness in the industry, which is further addressed in this thesis study as well.

To conclude, the main contribution of this study is twofold; first through theory extension proposed regarding TOC by integrating chaos theory and sustainability-oriented risk framework in its scope in reference to risks identified through different constraint propositions offered by related theories in the field; and second through the theoretical methodology proposed, in which the risks were identified in the comprehensive multiple case study conducted through the collection of dyadic data from several different supply chain members at different levels in a specific industry subjected to a sustainability-oriented prioritization. The resulting framework develops a sustainability framework on supply chain risk management strategies, and proposes an approach for assessing the sustainability orientation in supply chain risk management strategies.

Besides, utilizing multiple methodologies involving both qualitative and quantitative approaches through a moderate constructivist approach is followed by abductive reasoning (Järvensivu and Törnroos, 2010). Arguments were strengthened with the rich methodological framework of the study and the large sample size, which moved the entire framework towards crystallization (Richardson, 2000; Tracy, 2010), providing voluminous data and a wealth information to ensure comprehensive evaluation in addressing the major aims and research questions of the study. Especially, the involvement of consumers in the sampling scope and considering their insights and perceptions in the research phase (Olsson and Skjöldebrand, 2008;

Lusch, Vargo and Tanniru, 2010) has made a contribution to the marketing literature by taking an approach which considers the necessary involvement of consumers in strategy development process of value networks.

As a result, the concluding remarks and findings of this thesis refer to tangible as well as intangible aspects provided by the supply chains, which were highlighted to be critically important in creating value and in ensuring sustainable advantage (Allee, 2008; Kotler and Keller, 2012), and thus prominently contributes to the marketing literature on discussions related to value networks from a risk and sustainability perspective.

6.2. PRACTICAL IMPLICATIONS

This thesis study potentially provides academicians a new insight on extending different theoretical lenses towards sustainability in relation to risk. Moreover, the framework proposed for identifying generic supply chain risks from a theoretical perspective can help researchers as well as practitioners to understand the root causes of risks inherent in supply chain activities. On the other hand, the theoretical methodology proposed in the study provides a path for practitioners waiting to incorporate a sustainability framework into supply chain risk management strategies.

The supply chain wide analysis of the risk factors through the involvement of consumers addresses valuable insights by reflecting the perspectives of different members of supply chains at different levels. Those insights could also be used by the marketing practitioners working on the consumer side strategies. Besides, the evaluation of risk factors from different dimensions of sustainability distinctively develops a TBL perspective to risk assessment phase as well.

Furthermore, the industry-specific research conducted in food supply chains outlines important findings, which provide valuable insights both to supply chain research and to the practitioners in the industry. The risk factors identified are important to food companies working on their risk management programs and the sustainability-oriented evaluations made on those risk factors provide a potential direction for developing competitive risk management strategies accordingly.

From a sustainability framework, the emphasis outlined on behavioral risk factors in food supply chains can be useful in supporting marketing practitioners to develop strategies to further enhance especially consciousness related factors. Those findings not only increase industry practitioner awareness on mostly neglected behavioral risk factors, but also draw attention to their critical importance for all supply chain members who are the original risk makers.

6.3. LIMITATIONS AND DIRECTIONS FOR FURTHER RESEARCH

This study has its limitations, which also opens opportunities for future research. First, as in other case studies, there is the need to test the external validity of the proposed model by using a larger sample. It would be possible to enlarge this research towards other industries, and compare whether the risk factors or the emphasis on some risk factors differ across various industries.

Second, the decision strategy, risk environment and sustainability practices of private companies are likely to be different from those of publicly owned. Therefore, the sampling scope considering only the private companies is one limitation of this research, while opening another opportunity for future work with also publicly owned companies.

A third limitation relates to the bias which might have been caused by the sampling of a multiple-case study, due to interviewing same supply chain members, especially the upward chain members, for questioning the risk factors and sustainability practices at different food product supply chain types. Although distinct questions were asked for each product type to the respondents, it is likely that respondent bias was created while discussions were probed. Therefore, future studies should examine the upward side of the supply chains by selecting different respondents to question for each food product type differently.

Finally, discussions on exploring generic supply chain risk factors from the existing theories were based on ten theories only, although several others exist related to the theoretical focus of this study. Therefore, referring to ten theories in this discussion can be considered as another limitation of this study, which calls for

future work opportunities on extending this framework and supporting the discussions by other related theories.

This study provides valuable insights to motivate other future research opportunities as well. First, consumer side research could be extended and the research would specifically be conducted among the consumers in order to explore their own individual perceptions on supply chain risk factors. Moreover, the fuzzy AHP method, which was used to evaluate supply chain risk factors from a TBL sustainability framework, should be conducted with a larger sample of respondents, selected from outside of the multiple-case study. Besides, the entire research methodology should be carried out over the twenty three risk factor groups, which can be assessed either by fuzzy AHP again, or by other appropriate methods, including ANP. Furthermore, there is a rich opportunity for research on food supply chain risk factors to be probed, especially the risk factors of consciousness and complacency, as well as self-focus, ethics, opportunism and inertia risk factors, which were outlined to be less referred in the literature although emphasized by the respondents in the multiple-case study.

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APPENDICES

APPENDIX 1: SEMI-STRUCTURED INTERVIEW QUESTIONS

Q1: What are the most critical risk factors that affect food supply chain members?

Q2: Which logistics operations, and which food supply chain members are being affected by emerging risk factors?

Q3: Which logistics operations and which supply chain members are affected most, overall?

Q4: What are the most common strategies implemented to mitigate those risk factors?

Q5: Can you please give examples from the best-practice mitigation strategies (i.e. what should be implemented, rather than what is being implemented)?

Q6: What are the environmental sustainability nodes in food supply chain logistics operations?

Q7: What are the social sustainability nodes in food supply chain logistics operations?

APPENDIX 2: FUZZY AHP QUESTIONNAIRE

09.09.2014

Sayın Katılımcı,

Aşağıdaki soru formunda ikili karşılaştırmalı olarak belirtilen risk faktörlerinden çevresel, sosyal ve ekonomik sürdürülebilirliğe göre daha olumsuz etkisi olanı işaretledikten sonra, ne derece önemli bir etkiye sahip olduğunu verilen ölçek bilgileri doğrultusunda (1-3-5-7-9) işaretlemeniz gerekmektedir.

Soru formunu doldururken, aşağıdaki tüm risk faktörlerinin ve sürdürülebilirliğin boyutlarının tanımlarının yapıldığı bilgi formunu dikkatle okuyarak soruları cevaplamanızı önemle rica ederim.

Saygılarımla,

Aysu Göçer

Öğretim Görevlisi
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Lojistik Yönetimi Bölümü

BİLGİ FORMU

I. RİSK FAKTÖRLERİ

1. Yeterlilik Risk Faktörleri: (kabiliyet riski, kalite riski, kaynak riski, izlenebilirlik riski, bilgi riski)

Yeterlilik risk faktörleri, tedarik zinciri üyelerinin yeterli yetkinlik ve kabiliyete sahip olmamalarından kaynaklanan riskler olarak tanımlanabilir. Bu risk faktörleri kapsamında, teknolojik, insan gücü, çalışan, kaynak, yönetim gibi yetkinliklerin yeterli derecede olmama durumunun yanı sıra verimlilik, kalite, finansal, müşteri hizmetleri, izlenebilirliğin sağlanması, beklenmedik olaylara karşı hazırlıklı olma veya doğru/tam bilgiye ulaşma konularında kabiliyet ve yetkinliklerin eksik kalması sonucu oluşan her türlü olumsuzluk da değerlendirilebilir.

2. Davranışsal Risk Faktörleri: kayıtsızlık riski, bilinçsizlik riski, algı riski, işçi/çalışan riski, saygınlık riski

Davranışsal risk faktörleri, tedarik zinciri üyelerinin davranışlarına yansıyarak yürütülen tedarik zinciri faaliyetlerinde risk oluşmasına sebep olan ana etkenleri kapsamaktadır. Kültür, alışkanlıklar, kaderci yaklaşım veya eğitim, kötü tecrübeler gibi, davranışları etkileyen bir takım faktörler tarafından tetiklenen risklerin yanı sıra bilinçsizlik, bilgisizlik veya bilip de dikkate almama gibi riskli davranışları oluşturabilecek etkenler de bu kapsamda değerlendirilebilir. Bunun yanı sıra, vurdumduymazlık veya kayıtsızlık gibi önemsememe davranışına yol açan, ayrıca yanlış algının oluşması ve hatta saygınlık tehdidinin oluşması sonucu tetiklenen riskler de davranışsal risk faktörleri kapsamda yer almaktadır. Dolayısıyla, işçi, tüm çalışanlar ve hatta tüketicilerin de davranışlarına etki ederek risk oluşturabilecek her türlü faktör bu gruba girmektedir.

3. Yönetsel Risk Faktörleri: kontrol riski, yönetim riski, yasallık riski, bireysellik riski, planlama riski, atalet riski, sağlık ve güvenlik riski

Yönetsel risk faktörleri, tedarik zincirinde yönetimsel kaynaklı oluşabilecek riskleri kapsamaktadır. Bu grup, tedarik zinciri faaliyetlerini veya tedarik zinciri üyelerini yönetirken yeterli kontrol ve denetimin sağlanmaması, doğru yönetim yaklaşımımın izlenmemesi veya yasal gerekliliklere uyulmaması gibi sebeplerden oluşabilecek risklerin yanı sıra tedarik zincirinin bir bütün olarak yönetilmesi yerine zincir üyelerinin bireysel bakış açısı ile yönetilmesi ve kararların bu bireysellik doğrultusunda alınması sonucu oluşan riskleri de kapsamaktadır. Ayrıca, doğru planlamanın yapılmaması, sağlık ve güvenlik yönetiminin doğru, yeterli veya tam olarak yapılmaması ile sürekli gelişim stratejilerinin yönetim tarafından izlenip, benimsenip ilgili yeni uygulamaların takip edilip onlara adapte olunmaması ile bağlantılı oluşan riskleri de içermektedir.

4. Ahlaki Risk Faktörleri: etik riski, fırsatçılık riski

Ahlaki risk faktörleri, tedarik zinciri üyelerinin faaliyetlerini doğru, dürüst, etik ve ahlaki çerçevede yürütmeyerek ve bireysel çıkarları uğruna fırsatçı bir takım hileler uygulayarak yol açtıkları riskleri içermektedir.

5. Karşılıklı Bağımlılık Risk Faktörleri: yapısal risk, paydaş riski, dönemsellik riski, bağımlılık riski

Karşılıklı bağımlılık risk faktörleri, tedarik zincirinin kendi bünyesindeki ve çevresindeki üyeleri ve onların faaliyetleri ile sürekli etkileşim halinde işleyen yapısı ve dolayısıyla ortaya çıkan karşı bağımlılık durumu ile ilişkili olaraktan ortaya çıkan riskleri içermektedir. Bu, tedarik zinciri üyelerinin konumları, sayıları, boyutları, yetkinlikleri, yönetsel özellikleri, ilişkileri, bulundukları ülkelerin yasaları gibi konuların etkisiyle ortaya çıkan risklerin yanı sıra doğal afetler, mevsimsel farklılıklar, makro-ekonomik değişimler, paydaşların değişen hedef ve durumları

veya pazarın iç/dış dinamikleri, tedarik zincirinin karmaşıklığı gibi etkileşim gerektiren konulara bağlı olarak ortaya çıkan riskleri de içermektedir.

II. SÜRDÜRÜLEBİLİRLİK:

Çevresel Sürdürülebilirlik: Çevrenin, doğal kaynakların (toprak, hava, su, enerji…vb.) ve ekosistemin koruması ve gereksiz tüketimin engellenmesi gerekliliği olarak tanımlanabilir.

Sosyal Sürdürülebilirlik: Bireysel ve toplumsal refahın arttırılmasını hedefleyerek, güçlü bir toplumun eşitlik, adalet, toplumsal kalkınma gibi ilkeler doğrultusunda oluşturulması gerekliliği olarak tanımlanabilir.

Ekonomik Sürdürülebilirlik: Topluma katkı sağlayan ürün ve hizmetler üretirken, sermayenin (tüketilmeden) karlılık hedefi doğrultusunda istikrar ve kurumsal büyümenin sağlanması olarak tanımlanabilir.

SORU FORMU



(Kaynak: Saaty; 1980:54)

Çevresel Sürdürülebilirliğe (negatif) etkisi açısından daha önemlidir				**Önem Derecesi**				
				1	**3**	**5**	**7**	**9**
Yeterlilik Risk Faktörleri	☐	**Davranışsal** Risk Faktörleri	☐					
Yeterlilik Risk Faktörleri	☐	**Yönetsel** Risk Faktörleri	☐					
Yeterlilik Risk Faktörleri	☐	**Ahlaki** Risk Faktörleri	☐					
Yeterlilik Risk Faktörleri	☐	**Karşılıklı Bağlılık** Risk Faktörleri	☐					
Davranışsal Risk Faktörleri	☐	**Yönetsel** Risk Faktörleri	☐					
Davranışsal Risk Faktörleri	☐	**Ahlaki** Risk Faktörleri	☐					
Davranışsal Risk Faktörleri	☐	**Karşılıklı Bağlılık** Risk Faktörleri	☐					
Yönetsel Risk Faktörleri	☐	**Ahlaki** Risk Faktörleri	☐					
Yönetsel Risk Faktörleri	☐	**Karşılıklı Bağlılık** Risk Faktörleri	☐					
Ahlaki Risk Faktörleri	☐	**Karşılıklı Bağlılık** Risk Faktörleri	☐					

Sosyal Sürdürülebilirliğe (negatif) etkisi açısından daha önemlidir				**Önem Derecesi**				
				1	**3**	**5**	**7**	**9**
Yeterlilik Risk Faktörleri	☐	**Davranışsal** Risk Faktörleri	☐					
Yeterlilik Risk Faktörleri	☐	**Yönetsel** Risk Faktörleri	☐					
Yeterlilik Risk Faktörleri	☐	**Ahlaki** Risk Faktörleri	☐					
Yeterlilik Risk Faktörleri	☐	**Karşılıklı Bağlılık** Risk Faktörleri	☐					
Davranışsal Risk Faktörleri	☐	**Yönetsel** Risk Faktörleri	☐					
Davranışsal Risk Faktörleri	☐	**Ahlaki** Risk Faktörleri	☐					
Davranışsal Risk Faktörleri	☐	**Karşılıklı Bağlılık** Risk Faktörleri	☐					
Yönetsel Risk Faktörleri	☐	**Ahlaki** Risk Faktörleri	☐					
Yönetsel Risk Faktörleri	☐	**Karşılıklı Bağlılık** Risk Faktörleri	☐					
Ahlaki Risk Faktörleri	☐	**Karşılıklı Bağlılık** Risk Faktörleri	☐					

Ekonomik Sürdürülebilirliğe (negatif) etkisi açısından daha önemlidir				**Önem Derecesi**				
				1	**3**	**5**	**7**	**9**
Yeterlilik Risk Faktörleri	☐	**Davranışsal** Risk Faktörleri	☐					
Yeterlilik Risk Faktörleri	☐	**Yönetsel** Risk Faktörleri	☐					
Yeterlilik Risk Faktörleri	☐	**Ahlaki** Risk Faktörleri	☐					
Yeterlilik Risk Faktörleri	☐	**Karşılıklı Bağlılık** Risk Faktörleri	☐					
Davranışsal Risk Faktörleri	☐	**Yönetsel** Risk Faktörleri	☐					
Davranışsal Risk Faktörleri	☐	**Ahlaki** Risk Faktörleri	☐					
Davranışsal Risk Faktörleri	☐	**Karşılıklı Bağlılık** Risk Faktörleri	☐					
Yönetsel Risk Faktörleri	☐	**Ahlaki** Risk Faktörleri	☐					
Yönetsel Risk Faktörleri	☐	**Karşılıklı Bağlılık** Risk Faktörleri	☐					
Ahlaki Risk Faktörleri	☐	**Karşılıklı Bağlılık** Risk Faktörleri	☐					