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DOKUZ EYLUL UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
DEPARTMENT OF MARITIME BUSINESS ADMINISTRATION
MARITIME BUSINESS ADMINISTRATION PROGRAM
DOCTORAL THESIS
Doctor of Philosophy (Ph.D.)

**A LOGISTICS-ORIENTED SUPPLY CHAIN DESIGN
FOR REDUCING PRODUCT WASTE: A FRAMEWORK
FOR FOOD SUPPLY CHAIN**

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İZMİR-2020

APPROVAL PAGE



DECLARATION

I hereby declare that this doctoral thesis titled as “**A Logistics-Oriented Supply Chain Design for Reducing Product Waste: A Framework for Food Supply Chain**” has been written by myself in accordance with the 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.

02/09/2020

Ebru SÜRÜCÜ BALCI



THANKING

PhD is a long journey with many pitfalls. I would like to thank my supervisor Prof. Dr. Okan TUNA who encouraged me throughout to whole process, and advisory board members Prof. Dr. Omur Yasar SAATCIOGLU who helped me to choose my research topic and Assoc. Prof. Dr. Serdar TASAN who provided constructive feedback. In addition, I would like to thank 2211-A General Domestic Doctorate Scholarship Program (2211-A Genel Yurt İçi Doktora Burs Programı) who supported me through my doctorate.

I would like to dedicate my thesis to my father, my mother and my husband who is always there for me. Without your support, I could not achieve what I have achieved.

Ebru SURUCU BALCI

September, 2020

ABSTRACT

Doctoral Thesis

Doctor of Philosophy (PhD)

**A Logistics-Oriented Supply Chain Design for Reducing Product Waste: A
Framework for Food Supply Chain**

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Food loss is a major problem in the food supply chain and it has negative impacts on the environment, economy and society. Besides these negative impacts, food loss is one of the main challenges for ensuring food security. Hence, it is important to diminish food loss in food supply chains. For this purpose, this thesis aims to investigate how food loss reduction can be achieved to enhance food security within the food supply chains with the logistics viewpoint.

Food loss occurs throughout the upstream and midstream food supply chain, but it is not clear that specifically which stakeholders deal with food loss or in other words which stakeholders have more salience while dealing with the food loss. So, it is important to identify and classify stakeholders who have more salience while tackling food loss. In addition, to be able to tackle the food loss, it is important to identify food loss drivers. After identifying food loss drivers, it is important to rank food loss drivers which have a higher impact on the waste amount for reducing the overall food loss.

To fulfil these objectives, both qualitative and quantitative methods were employed in this study. To identify and classify stakeholders, systematic literature review, semi-structured interviews and stakeholder analysis were employed. To identify and classify food loss drivers, systematic literature review and semi-structured interviews were employed. To rank the food loss drivers,

which have a higher impact on the loss amount, the analytical hierarchy process was employed.

The results indicate that not all upstream and midstream stakeholders deal with the food loss with similar intensity. In addition, it has been identified that different factors and sub-factors cause food loss for each food supply chain. It has been determined that 3 main factors and 11 sub-factors lead to food loss in the fats and oil supply chain; while 3 main factors and 11 sub-factors cause food loss in the milk and dairy supply chain. It has been determined that 4 main factors and 13 sub-factors can cause food loss in the meat and poultry supply chain; while 3 main factors and 13 sub-factors lead to food loss in the fruit and vegetable supply chain. Furthermore, another key result of this thesis reveals that different sub-factors cause the most loss for different food supply chains. The thesis, which is prepared on the basis of qualitative and quantitative analysis results, offers implications for academics, practitioners and policy makers.

Keywords: AHP, Food Loss, Food Supply Chain, Logistics, Stakeholder Analysis, Stakeholder Identification and Salience Theory, Theory of Critical Success Factors

ÖZET

Doktora Tezi

Ürün Kayıplarının Azaltılmasına Yönelik Lojistik Yönlü Tedarik Zinciri

Tasarımı: Gıda Tedarik Zincirleri için Bir Çerçeve

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Gıda kaybı, gıda tedarik zincirinde önemli bir sorun olmakla birlikte çevre, ekonomi ve toplum üzerinde olumsuz etkilere yol açmaktadır. Bu olumsuz etkilerin yanı sıra, gıda kaybı, gıda güvenliğinin sağlanmasındaki temel problemlerin başında gelmektedir. Bu nedenle, gıda tedarik zincirlerinde gıda kaybını azaltmak önem arz etmektedir. Bu amaçla, bu tez lojistik bakış açısıyla gıda tedarik zincirlerinde gıda güvenliğini artırmak için gıda kaybını azaltmaya yardımcı olmayı amaçlamaktadır.

Gıda kaybı, yukarı ve orta akım gıda tedarik zincirinde meydana gelir, ancak özellikle hangi paydaşların gıda kaybıyla uğraştığı veya başka bir deyişle, gıda kaybıyla uğraşırken hangi paydaşların daha fazla öne çıktığı açık değildir. Bu nedenle, gıda kaybıyla mücadele ederken daha fazla öne çıkan paydaşları belirlemek ve sınıflandırmak önem arz etmektedir. Ek olarak, gıda kaybının üstesinden gelebilmek için, gıda kaybını tetikleyen faktörleri belirlemekte önem arz etmektedir. Ayrıca gıda kaybına neden olan faktörler belirledikten sonra, gıda kaybını azaltmak için atık miktarı üzerinde daha yüksek etkiye sahip olan gıda kaybı faktörlerini sıralamak kayıp olan miktarı azaltmak için önem taşımaktadır.

Bu amaçları gerçekleştirmek için bu çalışmada hem nitel hem de nicel yöntemler kullanılmıştır. Paydaşları belirlemek ve sınıflandırmak için sistematik literatür taraması, yarı yapılandırılmış görüşmeler ve paydaş analizi uygulanmıştır. Ayrıca, gıda kaybı etkenlerini belirlemek ve sınıflandırmak için

sistemantik literatür taraması ve yarı yapılandırılmış görüşmeler uygulanmıştır. Kayıp miktarı üzerinde daha yüksek etkiye sahip olan gıda kaybı faktörlerini sıralamak için ise analitik hiyerarşi süreci uygulanmıştır.

Sonuçlar, tüm üst ve orta akım tedarik zinciri paydaşlarının gıda kaybına benzer yoğunlukta maruz kalmadığını göstermektedir. Bunun yanı sıra her bir gıda tedarik zinciri için farklı faktör ve alt faktörlerin gıda kaybına yol açtığı tespit edilmiştir. Katı ve sıvı yağ tedarik zincirinde 3 ana faktör ve 11 alt faktör gıda kaybına yol açtığı tespit edilmiştir. Süt ve süt ürünleri tedarik zincirinde 3 ana faktör ve 11 alt faktör gıda kaybına yol açtığı tespit edilmiştir. Et ve kümes hayvanları tedarik zincirinde 4 ana faktör ve 13 alt faktörün gıda kaybına sebep olabileceği belirlenmiştir. Meyve ve sebze tedarik zincirinde 3 ana faktör ve 13 alt faktörün gıda kaybına yol açtığı tespit edilmiştir. Ayrıca her bir gıda türü için en çok kayba sebep olan alt faktöründe farklı olduğu tespit edilmiştir. Kalitatif ve kantitatif analiz sonuçlarına dayalı olarak hazırlanan bu çalışma akademisyenler, uygulayıcılar ve politika belirleyiciler için çıkarımlar sunmaktadır.

Anahtar Kelimeler: AHS, Gıda Kaybı, Gıda Tedarik Zinciri, Kritik Başarı Faktörleri Teorisi, Paydaş Analizi, Paydaşların Belirlenmesi ve Önceliği Teorisi

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ABBREVIATIONS

AHP	Analytical hierarchy process
ASF	Animal-sourced food
CH₄	Methane
CI	Consistency Index
CR	Consistency Ratio
CSF	Critical success factor
CO₂	Carbon dioxide
COMCEC	Standing Committee for Economic and Commercial Cooperation of the Organization of Islamic Corporation
CUMS	Critical upstream and midstream stakeholder
FV	Fruit and vegetable
MDP	Milk and dairy products
MP	Meat and poultry
EIU	The Economist Intelligence Unit
EPA	United States Environmental Protection Agency
FAO	Food and Agriculture Organization
FCNR	Food Climate Research Network
FO	Fats and oil
FSC	Food supply chain
HPLE	High level panel of experts
GHG	Greenhouse Gas
LCFLD	Logistics-related critical food loss driver

MCDM	Multi-criteria decision method
NGO	Non-governmental organizations
N₂O	Nitrous oxide
OECD	The Organization for Economic Cooperation and Development
SIST	Stakeholder identification and salience theory
SRI	Stanford Research Institute
TCSF	Theory of critical success factor
UK	United Kingdom
UN	United Nations
USA	United States of America
USD	United States Dollar
USDA	United States Department of Agriculture
USGS	U.S. Geological Survey
WFP	United Nations' World Food Program
WHO	World Health Organization
WRAP	Waste and Resource Action Program

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CHAPTER I

INTRODUCTION

1.1. RESEARCH PROBLEM AND AIM OF THE STUDY

Food security is a fundamental human right which states that each human should have physical, social and economic access to sufficient, safe and nutrient food at all times considering their needs and preferences for active and healthy life (Food and Agriculture Organization - FAO, 2002). However, food loss and waste is a severe threat to food security (Ishangulyyev et al., 2019). Globally, each year 1.6 billion tons of food is wasted, which equals one-third of all produced product in the world (FAO, 2020e). The monetary equivalent of the amount of the loss and waste equals to USD 1 trillion, the environmental cost is USD 700 billion, and social cost is approximately USD 900 billion (FAO, 2020b).

From a financial perspective, food wastage is a sunk investment that diminishes incomes of farmers and increases expenses (Lipinski et al., 2013). Amount of food wastage directly affects the income of farmers (Gustavsson et al., 2011; Lundqvist et al., 2008). When a portion of food is wasted, the money spent on water, energy and labor also turns into a loss. The wasted food also causes an increase in cost per unit and, thereby, an increase in consumer prices (Buzby and Hyman, 2012).

The negative impact of food loss and waste is not only experienced in the economy but the environment and society. When a portion of food is wasted, the water, energy, labor and land used to grow, process, transport and package that food also turn into waste. Water is the source of life, and the essential liquid in the ecosystem and agriculture is the biggest user of Earth's available "freshwater". 70% of the freshwater pull-outs are for agricultural usage. Thus, when the food turns into waste, the water used to grow such food also becomes waste. According to Vittuari et al. (2016), more than 20 % of the energy output of all food is wasted. The workforce that spent during the production of food is lost when the food becomes waste. To grow food which is wasted each year, an area larger than China is required (FAO, 2019a).

Moreover, both production and wastage of food increase emission amounts of hazardous gases. Poore and Nemecek (2018) found that 26 % of the overall greenhouse

gas (GHG) emission comes from food production. Ritchie (2020) mentioned that food loss and waste generates 6% of total global greenhouse gas emissions. If the GHG amount of waste examines in the country context, it would be the third-largest emitter after China and the United States (Ritchie, 2020). Furthermore, when the wasted food ends up in landfills, methane gas, which is 25 times more hazardous than carbon dioxide (CO₂) (EPA, 2016), is emitted, which further impacts negatively on the environment.

Waste of scarce resources leads to inequality and creates danger for the future (Roka, 2019). Moreover, food loss leads to malnourishment and food insecurity. In 2019, the world population was 7.7 billion, and 820 million people were food insecure (FAO, 2019b). The projections demonstrate that the world population will reach 9.8 billion in the year 2050 (United Nations - UN, 2019). To cope with the demand, food systems can either produce more or waste less. Currently, the yearly wasted food amount is enough to feed 2 million people meaning that if the food system can eliminate the loss and waste, then the problem of hunger will be solved.

Parallel to the seriousness of the subject, researchers, governments and non-governmental organizations (NGOs) pay more attention to food loss and waste issue and try to offer solutions. For instance, in the UK, reports and statistics about food loss and waste has been published since 2000 (Waste and Resource Action Program - WRAP, 2020); while in the USA, statistics and reports have been regularly published since 2010 (United States Department of Agriculture - USDA, 2020). In addition to government institutions, international establishments such as Food and Agriculture Organization (FAO) of the United Nations and The Organization for Economic Cooperation and Development (OECD) also tackle with the food loss and food waste phenomena and reveal statistics for the USA, members of the European Union and the UK.

In recent years, a growing trend occurs for food loss and food waste publications in the literature (Surucu Balci and Tuna, 2019; Hodgins and Parizeau, 2020; Yetkin Ozbuk and Coskun, 2020). However, Xue et al. (2017) stated that majority of the studies addressed the food waste issue for retailing, and consumer stages for developed country context, much fewer studies addressed the food loss issue for the first stages of the food supply chain (FSC) for developing country context.

In the last ten years, the importance given to food loss and waste concepts has gained momentum in Turkey. In the year 2013, FAO conducted a study to quantify food loss and waste in different commodity groups as a part of the global scale project (Tatlidil et al., 2013). In this report, it has been identified that in Turkey, more food turns into waste at the upstream and midstream supply chain activities compared to downstream supply chain activities (Tatlidil et al., 2013). Following this initiative, few reports were prepared by the Turkish government by the Ministry of Customers and Trade and the Ministry of Trade in the year 2017, 2018 and 2019. However, these prepared reports were not solely dedicated to food loss and waste. Alongside food loss and waste, water, energy, and textile waste were also reported. In addition, most of the food-related statistics were provided for downstream supply chain activities which are retailing and consumption (TISVA, 2019). However, on the 20th of May 2020, a new campaign “Save Your Food: Your Actions Matter”, which is a joint initiative of FAO and Ministry of Agriculture and Forestry of Turkey, has started (FAO, 2020a).

During the publicity meeting of this campaign, Minister of Agriculture and Forestry stated that in Turkey, most of the food wastage occurs during harvesting, warehousing, processing, and distribution stages, in other words at upstream and midstream supply chain activities (Anadolu Ajansı, 2020). The wastage occurs at these stages are considered as “food loss” (FAO, 2019a). According to FAO report, in Turkey, 30% of the fruit and vegetable products turn into loss at the upstream and midstream supply chain activities; while 5% of the fruit and vegetable products turn into waste at the downstream supply chain activities (Tatlidil et al., 2013). The same report states that 17.7% of the meat and poultry loss occurs at the upstream and midstream supply chain activities; while 1% of the waste occurs during the downstream supply chain activities (Tatlidil et al., 2013). 18.5% of the milk and dairy product loss at the upstream and midstream supply chain activities; while 1.5 % of the milk and dairy products waste at the downstream (Tatlidil et al., 2013). 28% of the fats and oil products loss at the upstream and midstream supply chain activities; while 4 % wastes at the downstream supply chain activities (Tatlidil et al., 2013).

In a developing country such as Turkey, more food loss occurs than food waste in different FSCs, as it is also stated in the literature (Papargyropoulou et al., 2014; Secondi et al., 2015; Alamar et al., 2018; Govindan, 2018). In developing countries

food loss occurs mainly due to lack of technology, problems in transportation infrastructure and storage, lack of financial, technical and managerial resources, inefficiency of production are the main reasons of (Parfitt et al., 2010; Gustavsson et al., 2011; Secondi et al., 2015; Surucu Balci and Tuna, 2020). While food waste mainly occurs due to cultural, behavioral, economic decisions of individuals or households (Secondi et al., 2015; Surucu Balci and Tuna, 2020). The main reason of why more food loss occurs in developing countries are lack of technologies, problems occur in transportation infrastructure. However, there is minimal research conducted about food loss in Turkey. For instance, Kazancoglu et al. (2018) conducted a study on the milk supply chain to identify causes of raw milk loss, quantify the lost amount in the supply chain and suggest solutions to achieve sustainable milk supply chain in Turkey. Ertan et al. (2019) conducted a study on fruit and vegetable supply chain, specifically fig. In this study, the impact of transportation-related factors on the amount of freshly harvested product loss was investigated. Kayikci et al. (2019) conducted a study to diminish food loss on the Turkish meat supply chain to make the meat sector more sustainable and circular and offered solutions. Despite these pioneer studies there is still a gap in the literature regarding the food loss issue in Turkey.

Besides the lack of food loss studies in Turkey, there is also a gap in the literature within the international domain regarding the cause of food loss (Xue et al., 2017). In fact, majority of the studies addressed the food waste issue for retailing, and consumer stages for developed country context, much fewer studies addressed the food loss issue for the first stages of the FSC for developing country context (Xue et al., 2017). Furthermore, in the international domain, no study has conducted to identify reasons for food loss in different food supply chains from the logistics point of view. Only Liljestrand (2017) offered logistics related solutions to food loss drivers which were identified by Mena et al. (2011). However, drivers, which were identified by Mena et al. (2011) -megatrends, natural constraints and management root causes- were not determined from the logistics point of view.

This thesis aims to investigate how food loss reduction can be achieved to enhance food security within the food supply chains with the logistics viewpoint. For this aim, the upstream and midstream supply chain activities of fats and oil supply

chain, milk and dairy product supply chain, meat and poultry supply chain and fruit and vegetable supply chains are investigated.

Food loss occurs throughout the FSC, but it is not clear that specifically which stakeholders deal with food loss or in other words which stakeholders have more salience while dealing with the food loss. It is essential to understand whether food loss drivers (reasons) change according to stakeholders while offering solutions. Thus, identifying and classifying stakeholders who are salient while dealing with food loss is crucial. For this purpose, the first objective of this thesis is established as follows:

O1: To identify and classify critical upstream and midstream stakeholders (CUMSs) who have more salience while tackling with the food loss on the FSC.

Food loss drivers are critical factors which lead to the loss. While tackling food loss in the FSC, knowing the drivers of food loss is essential, especially to offer specific solutions. As it is mentioned in the literature, different drivers lead to food loss, including production, quality and aesthetic standards (Secondi et al., 2015). Instead of focusing all food loss drivers, this thesis is going to focus on logistics infrastructure-related drivers via adopting a logistics viewpoint. Because of this focusing, the identified drivers are going to be named as logistics-related critical food loss drivers (LCFLDs). To diminish the food loss in the upstream and midstream of four food supply chain, it is essential to define the LCFLDs. For this purpose, the second objective of this thesis is determined as follows:

O2: To identify and classify logistics-related critical food loss drivers (LCFLDs).

Identifying LCFLDs for different food types is not sufficient while tackling with food loss. Offering suggestions to identified LCFLDs are also crucial. Considering the food characteristics of different food types, it is expected that different LCFLDs will lead to more food loss. Therefore, LCFLDs causing more food loss in each food group should be identified, and suggestions must be provided accordingly. Thus, for this purpose, the third objective of this thesis is identified as follows:

O3: To rank the logistics-related critical food loss drivers, which have a higher impact on the waste amount, for reducing the overall food loss.

After prioritization of LCFLDs for each supply chain, suggestions will be provided to ensure food security via tackling food loss.

1.2. THEORETICAL FOUNDATIONS OF THE STUDY

The theoretical underpinning of the thesis was ensured with the utilization of stakeholder identification of salience theory (SIST) and theory of critical success factors (TCSFs).

SIST is developed as a response to critics of the stakeholder theory by Mitchell, Agle and Wood in 1997. According to stakeholder theory, organizations need to protect not only their shareholders' interests but also their suppliers, employees and local communities' interests (Freeman, 1984). Not only caring about stakeholders but also creating values for the stakeholders is a source of competitive advantage according to stakeholder theory (Freeman et al., 2010). According to this point of view, identification and value creation are essential for the survival of the organization. However, identifying and prioritizing stakeholders are quite complex tasks (Best et al., 2019) and stakeholder theory falls short of achieving it (Ambler and Wilson, 1995; Donaldson and Preston, 1995; Cummings and Patel, 2009; Mitchell et al., 1997; Wood et al., 2018). To overcome this deficiency, stakeholder identification and salience theory can be utilized (Mitchell et al., 1997; Neville and Menguc, 2006; Wood et al., 2018).

SIST is defined as *“the degree to which managers give priority to competing stakeholder claims”* (Mitchell et al., 1997). There are three main attributes of SIST which are power, legitimacy and urgency and theory provides an understanding of how the combination of power, legitimacy and urgency leads to form different stakeholder types with different behavioral patterns considering the organization (Mitchell et al., 1997). Based on possessing the attributes, stakeholders are classified according to seven types. The central proposition of this theory is *“stakeholder salience will be positively related to the cumulative number of stakeholder attributes – power, legitimacy and urgency- perceived by managers to be present”* (Mitchell et al., 1997). Moreover, Mitchell et al. (1997) identified several additional attributes to ensure dynamism of the theory which are stakeholder attributes are variable, socially constructed, and consciousness and willful exercise may or may not be present.

FSC is a complex structure with different stakeholders and different activities. To tackle food loss in the supply chain, it is essential to know which stakeholders deal

with food loss at which level. Each stakeholder will be affected differently from food loss. Thus, it is essential to reveal which stakeholders struggle more with food loss. However, stakeholder theory implies that stakeholders are classified based on predetermined stakeholder types such as primary-secondary, active-passive, narrow-wide (Evan and Freeman, 1988; Carroll, 1993; Morgan and Hunt, 1994). These classifications in the literature are stable, predetermined and difficult to change classifications once it is set. However, FSCs are dynamic and, same supply chain members can be classified in different for different food types when endeavoring with food loss. Thus, instead of using predetermined and stable stakeholder groupings, in this dissertation, a model which is dynamic and includes different stakeholder types is used. In addition, the adopted model (SIST) allows identifying stakeholders with discussion.

Theory of critical success factors (TCSFs) suggests that in the case of achieving satisfactory results in certain areas which are chosen as success factors will enable competitive advantage to organizations (Shankar et al., 2018). Critical success factors (CSFs) are also known as “key factors”, “success factors” or “critical factors” (Marais et al., 2017). The theory implies that several critical concepts affect the success and efficiency of an organization while enabling a firm to reach its goals. Identifying CSFs is not related to gathering information for strategic planning. Instead, CSFs focus on the organization’s needs to identify, manage, and control the data, which can be used for monitoring and improving existing business areas. The core of the CSF theory implies that firms should focus on their resources and factors that provide them with a competitive advantage (Rockart, 1979; Ferguson and Dickinson, 1982; Leidecker and Bruno, 1984). CSFs are not the firm’s objective or goal, but they are enablers for a firm to achieve its objectives or goals (Brotherton and Shaw, 1996). CSFs can be specified from not only the firm’s internal and external environments but also a wide variety of cases, situations, events that firm needs to focus specifically (Dickinson et al., 1984). However, CSFs are not compared with performance indicators (Freund, 1988).

TCSFs argue that some factors can be a key success or failure factor (Aschemann-Witzel et al., 2017). The decision of success or failure factor is related to how the stakeholders deal with the issue and how internal and external factors affect

each other. This argument is also valid for complex cases such as tackling food loss. Food loss occurs due to various reasons such as quality standards, environmental factors, inadequate production technologies, lack of infrastructure (Gustavsson et al., 2011; Papargyropoulou et al., 2014).

There is no clear definition for the critical factors. In this thesis, the critical factor concept was applied to different actors and different food loss drivers across the upstream and midstream supply chains. While tackling food loss in the upstream and midstream supply chain, it is important to know which stakeholders deal with food loss and how this stakeholder can be involved with offered solutions. Thus, the identified stakeholders who deal with food loss drivers is going to be named as "critical upstream and midstream stakeholders (CUMSs)". In addition, identifying food loss drivers which are critical from a logistics point of view is important. Thus, identified drivers which lead to food loss in the upstream and midstream is going to be named as "logistics-related critical food loss drivers (LCFLDs)".

1.3. THE RESEARCH DESIGN OF THE STUDY

The research design enables to identify what precisely this thesis expects to find, define the scope of this thesis to fulfil the aim of the thesis, and justify the selected methods to ensure the expected aim is reached. In social science studies, to understand a phenomenon, the factors which constitute the phenomenon, should be modelled (Babbie, 2016).

Research model starts with an interest or a research problem. Interest, idea and theory are three critical steps of a research process which feed each other simultaneously and based on the helps each other to finalize the arguments (Babbie, 2016). While defining the research process, two approaches can be adopted empirical and non-empirical. Having at least one of the following interest, idea, and theory requires an empirical approach (Babbie, 2016). The empirical approach is adopted as a scientific approach in this thesis.

As it is explained above, food loss jeopardizes food security, and it needs to be eliminated or diminished to ensure food security within FSC. To diminish the amount of food loss, it is important to know who deals with loss and what are the reasons for

the loss in the upstream and midstream supply chain. So, the interest, which ended up as this thesis, is to understand the reasons behind the food loss in the FSC. To theoretically underpin the interest and form research idea, research model needs to be supported with theories. Therefore, stakeholder identification and salience theory (SIST) and theory of critical success factors (TCSFs) were utilized in the study. With the help of identified theories and research interest finalized the research interest. The research idea finalized as to understand who deals with food loss in the FSC and identify the reasons that lead to food loss in FSC from the logistics point of view. And based on the research interest aim and objectives of the study were defined.

To identify all reasons for an event, an idiographic explanation should be utilized (Babbie, 2016). Thus, in this thesis, the idiographic explanation is adopted as explanation power. So, while identifying the aim and objectives of this study, it was known that all possible stakeholders who deal with food loss and all logistics-related drivers need to be explored and analyzed to offer the solutions.

While conducting research, a study has at least one of the following purposes, which are exploratory, descriptive or explanatory (Babbie, 2016). This thesis aims to explore the stakeholders who deal with food loss in the upstream and midstream supply chain. Also, the study explores the logistics-related food loss drivers in the upstream and midstream supply chain. In addition, the descriptive aim of this thesis is to define both the stakeholders and logistics-related drivers. The study also makes explanatory efforts while classifying both stakeholder groups who need to be explicitly interested and logistics-related drivers.

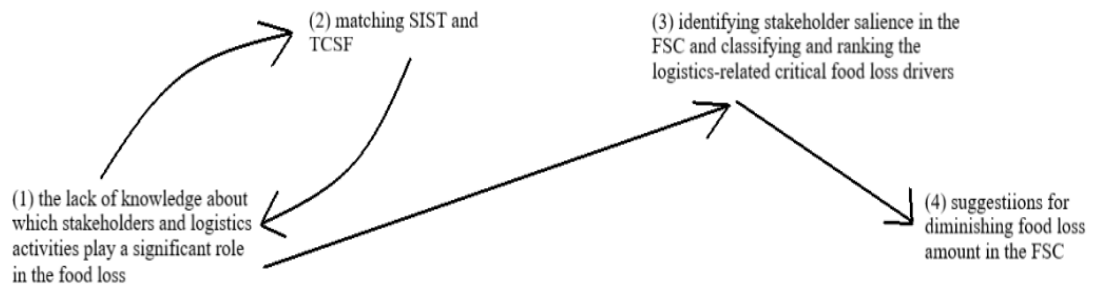
For research philosophy, this study adopted pragmatism. Typical pragmatic research starts with a research problem or research interest, and through considering theories and employing methods offers new solutions. In line with pragmatism, this study also started with a research interest which is underpinned with theories. As a reasoning method, this dissertation interiorized abductive reasoning. The basis and results of abductive research are based upon combining theoretical knowledge and real-life observations, which enables providing suggestions based on the theory (Kovacs and Spens, 2005).

Abductive reasoning mainly suits for the topics where a wealth of information in one context is available but far less in the context that in the research area. Since

this is the situation that occurs in this research context of this thesis, we decided to use abductive reasoning, which enables us to backwards and forward within the theory and data. The abductive reasoning approach consists of four steps, which is shown in Figure 1. Abductive reasoning starts with a phenomenon which requires understanding. Second, theory(ies) are required to match with the investigated phenomenon. The third step is revealing new understandings. The last step is offering suggestions based on new understandings.

For this thesis, previous knowledge consists of the basis of abductive research. In this case, although it is clear that food is lost at different stakeholders as a result of logistics activities, the knowledge of which stakeholders and logistics activities play a significant role in the food loss lacks. While investigating this phenomenon, to ensure theoretical underpinning stakeholder identification and salience theory and theory of critical success factors were employed.

Figure 1: The Abductive Process of the Thesis



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In this thesis, the phenomenon requires understanding is the lack of knowledge about which stakeholders and logistics activities play a significant role in food loss. Thus, to explore this research interest, SIST and TCSFs were utilized. With employing methods, the new understandings which are identifying CUMSs in four different food supply chains and classifying and ranking the LCFLDs. Lastly, suggestions were offered to diminish the food loss in the FSC.

The mixed-method is applied to accomplish research objectives. To fulfil both objectives, systematic literature review, semi-structured interviews and analytical hierarchy process (AHP) were utilized. In terms of time horizon, this thesis is

considered as a cross-sectional study since the thesis provides a snapshot of current food supply chains. Table 1 shows that the research design criteria were adopted for this thesis.



Table 1: Research Design Criteria

Research design criteria	How it is applied in this thesis
Scientific approach	Empirical
Model of explanation	Idiographic
Research purpose	Explanation and description (exploration also contributes to the process, yet it is not the main purpose)
Research philosophy	Pragmatism
Reasoning method	Abductive
Research method	Mixed method (systematic literature review, semi-structured interviews, AHP)
Time dimension	Cross-sectional
Research type	Applied field research
Unit of analysis	Organizations (organizational stakeholders)
Research type	Applied field research

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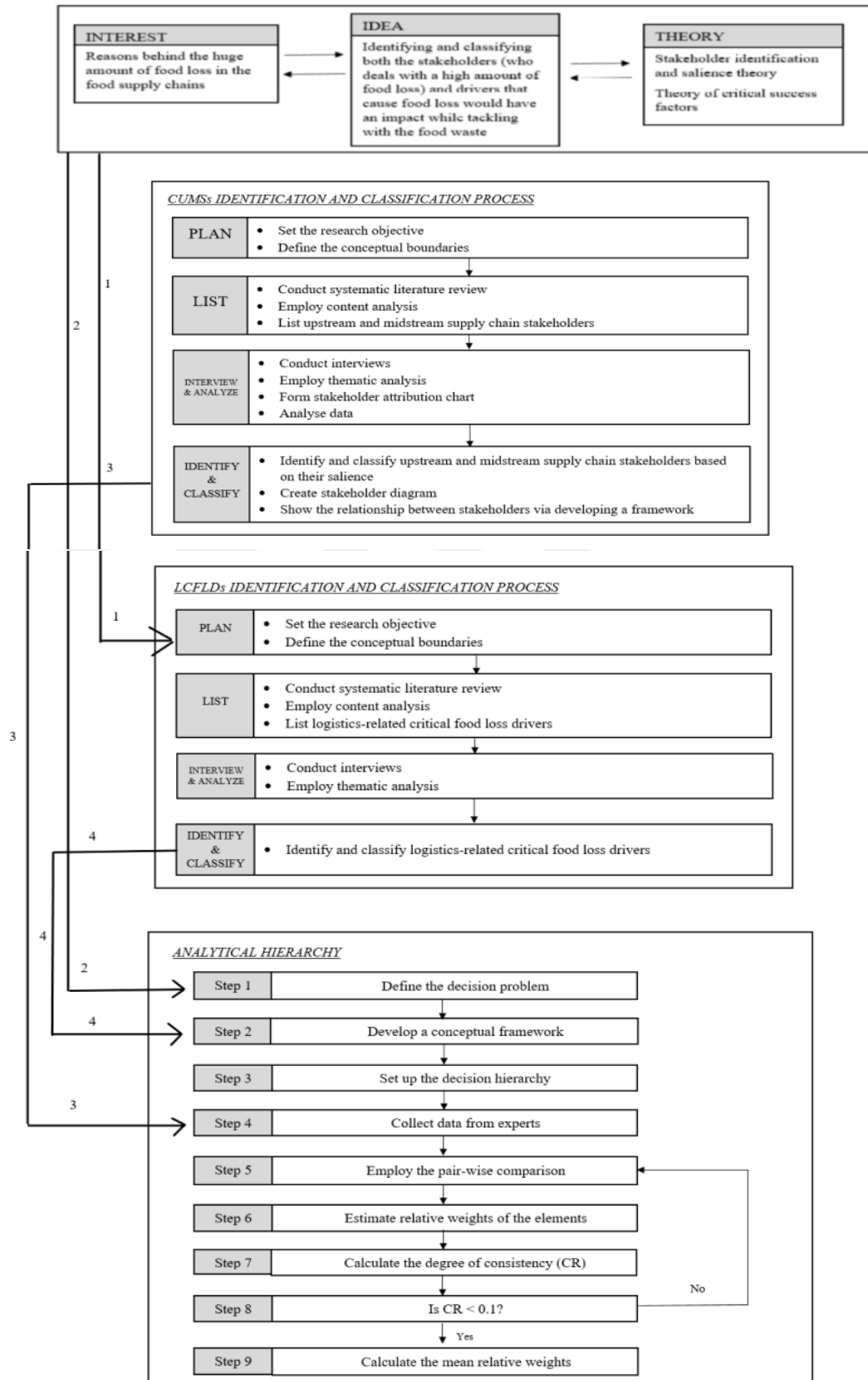
Once the interest, research idea and theories utilized the research aim and objectives, data collection process began. To identify and classify CUMSs, both primary and secondary data were employed. As for secondary data, a systematic literature review was conducted to identify all stakeholders from across countries and for four FSCs. The primary data was collected with semi-structured interviews and stakeholder attribution chart. For the systematic literature review, Bossle et al. (2016) and Petticrew and Robert (2006)'s protocol, which was explained in the methodology section, was adopted. The extracted articles were analyzed with content analysis. NVIVO12 used for coding the extracted data, and with the help of analysis, a stakeholder list was prepared, which includes all upstream and midstream stakeholders. To validate whether the identified stakeholders also occur in the Turkish food supply chains, semi-structured interviews were conducted. As a sampling method, purposive sampling was employed. Overall, 24 interviews were conducted with different stakeholders from the FSCs. All interviews were recorded and transcribed verbatim. Thematic analysis was used to analyze the data. For coding the

data, NVIVO12 was employed. For the thematic analysis, Braun and Clarke (2006)'s protocol was employed. At the end of this process, all critical upstream and midstream stakeholders who deal with food loss is identified. To classify them, a stakeholder attribution chart was used. To analyze the extracted data from the stakeholder attribution chart, Tsoufas et al. (2019)'s protocol was adopted. As a result of this analysis, stakeholder classification was completed.

To identify and classify LCFLDs, both primary and secondary data were utilized. As a secondary data, a systematic literature review was conducted to identify all logistics-related drivers for FSCs. The primary data was collected with semi-structured interviews. Similar to the first systematic literature review, Bossle et al. (2016) and Petticrew and Robert (2006)'s protocol, were adopted. The extracted articles were analyzed with content analysis. NVIVO12 was used for coding the extracted data, and with the help of the content analysis, a list including all LCFLDs was created for upstream and midstream supply chain. To validate whether the identified drivers also occur in the Turkish FSCs, semi-structured interviews were conducted. As a sampling method, purposive sampling was employed. Overall, 39 interviews were conducted with identified stakeholders. All interviews were recorded and transcribed verbatim. For coding the data, NVIVO12 was employed. Thematic analysis was used to analyze the data. For the thematic analysis, Braun and Clarke (2006)'s protocol was employed. At the end of this process, for each food type, main and sub LCFLDs were classified.

To prioritize the identified and classified LCFLDs, AHP was employed. For the analysis, the protocol which was outlined by Saaty (1999, 2004, 2008), were utilized. Thus, after developing the conceptual framework, LCFLDs hierarchy were formed for each FSC. Then, AHP questionnaire was disseminated. Purposive sampling was used while selecting experts. Seven experts completed the AHP questionnaire for fats and oil supply chain. Eleven experts completed the questionnaire for milk and dairy supply chain. Fourteen experts completed the questionnaire for meat and poultry supply chain. Nineteen experts completed the questionnaire for fruit and vegetable supply chain. The extracted data were analyzed according to the mathematical notion of AHP, which is explained in the methodology section. Figure 2 shows the research process of this thesis.

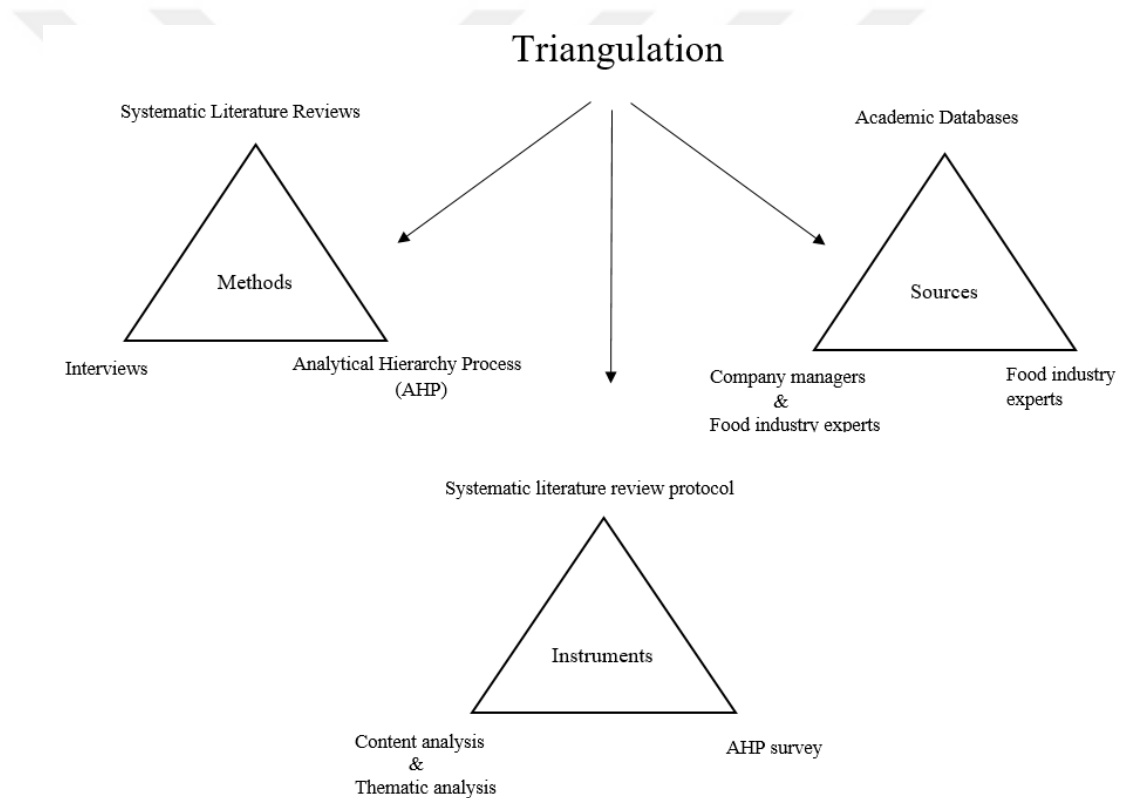
Figure 2: The Research Process



Resource: Compiled by author (adapted from Babbie, 2016)

As it is understood from the research design, both qualitative and quantitative methods applied in this study. Utilization of these methods is called triangulation (Matthews and Ross, 2010). Triangulation is a practical approach, especially examining the same phenomenon by using different methods (Jil, 1979). There are four types of triangulation commonly applied, which are the source of data (instrument) triangulation, observer triangulation, theory triangulation and method triangulation (Denzin, 1978). In this study, methods, sources and instruments triangulation were achieved. Figure 3 shows the achieved triangulation framework.

Figure 3: The Framework of Data Triangulation



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The source of data triangulation was ensured by using different sources while both identifying and classifying CUMSs and LCFLDs. These sources were academic databases, company managers and food industry experts.

1.4. STRUCTURE OF THE THESIS

This thesis is structured in six chapters. Chapter 2 provides a detailed explanation of the global food systems, factors that impact global food systems, the importance of food security and how food loss threatens food security.

The theoretical underpinning of the thesis is explained in Chapter 3. To fulfil research aim, stakeholder identification and salience theory and theory of critical success factors are utilized. In this chapter, theoretical background, justifications and assumptions of each theory are explained. Furthermore, in this chapter, it is explained how each theory is adopted for the objectives of the thesis.

Chapter 4 is the methodology section. This section was prepared based on Saunders et al (2016)'s research onion concept. In this chapter, decisions such as research philosophy, approach, methodological choices, sampling methods, and sample features were highlighted. Moreover, the validity and reliability of the employed methods are presented in this chapter.

In chapter 5, the analysis and results of the thesis are provided. First, the results of the stakeholder analysis were presented. After identifying and classifying stakeholders (CUMSs), food loss drivers (LCFLDs) were identified and classified considering logistics point of view, which was followed by ranking LCFLDs according to their impact level on the amount of food loss.

Finally, the theoretical contribution of the thesis based on the discussion of results was provided in Chapter 6. A practical implication section followed this. Lastly, the limitations of the study and further research ideas were discussed in this chapter.

CHAPTER II

GLOBAL FOOD SYSTEM AND FOOD LOSS

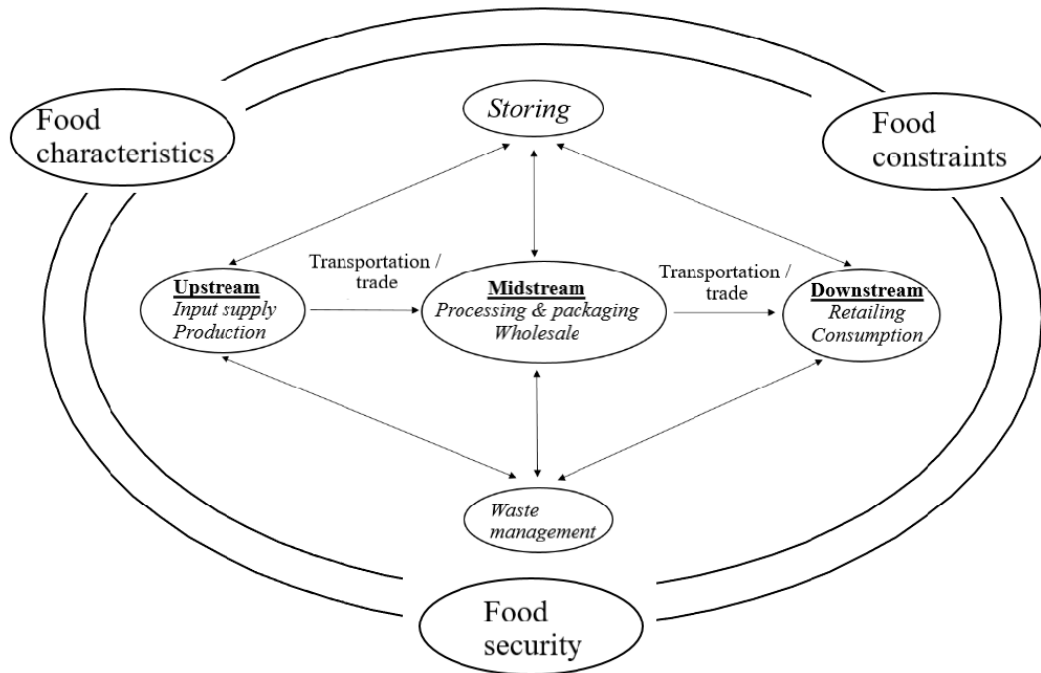
2.1. GLOBAL FOOD SYSTEM

Food systems are complex and include different members around the world. The food system is defined as “*the complete set of people, institutions, activities, processes and infrastructure involved in producing and consuming food for a given population*” (UNEP, 2016). It includes all supply chain activities including cultivation, growing, harvesting, farming, processing, producing, packaging, distributing, retailing, wholesaling, selling, consuming, managing waste and all the entities from farmers and livestock owners to producers, distributors, retailers and consumers (Gamboa et al., 2016; CFSA, 2012; Ericksen, 2008; Foresight, 2011). Food characteristics and constraints are important factors while determining the activities. Thus, food systems are interested in food characteristics and food constraints. Moreover, challenges within the system and developments in the system are taken into account when making decisions in the food system.

The food system combines three aspects of life; biological, economic and political, and social (Tansey and Worsley, 1995). Biological aspect mainly deals with producing food from living creatures and maintaining their sustainability. The economic and political aspect is generally related to how different actors of the supply chain hold power and control the rest of the system (Gamboa et al., 2016). The social aspect deals with the cultural traditions, values and relations which affect the people's usage and consumption patterns (Tansey and Worsley, 1995). The food system is mostly cyclical as well as being linear in some cases.

Food systems deal with activities, actors, food characteristics and food constraints as well as the challenges of the system and developments within the system (FCRN, 2015). Multiple food systems operate at the same time to feeding the populations. All systems interact with each other in harmony, yet the level of interactions change. Figure 4 shows a typical food system with crucial decision criteria.

Figure 4: The Food System



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Food systems consist of food supply chains (FSCs). FSCs consist of activities and actors. FSCs are highly globalized and dynamic systems; thus, information, food and funds constantly flow within the FSC. Food systems are dynamic and complex systems challenged by ensuring food security (Manzini and Accorsi, 2013; Li et al., 2014). Thus, actors have to consider food characteristics and food constraints all the time while deciding the activities. In this section, information about food supply chains, food characteristics, food security and challenges which have an impact on ensuring food security are going to be explained.

2.1.1. Food Supply Chain

The food supply chain is defined as “a set of interdependent companies that work closely together to manage the flow of goods and services along the value-added chain of agricultural and food products, to realize superior customer value at the lowest possible costs” (Folkerts and Koehorst, 1998). FSCs are complex, dynamic and globalized networks that require collaboration and coordination between actors. FSCs consists of a chain of activities including producing, processing/packaging,

wholesaling/retailing, consuming, storing, disposing and transporting. Actors of FSC are heterogeneous but interdependent who implement a group of activities to transform food materials to customers' requested final food products (Memon, 2014). Wide range of actors takes part in these activities from input supplier to manufacturer, to people who are responsible from the transportation and storing of the raw, semi-finished and finished products, and food service industry and consumers and people who manage the waste consumers (Fredriksson and Liljestrand, 2015; Mattevi and Jones, 2016). Each activity includes both small and medium-sized enterprises and public and private entities. When a decision is taken at one activity by one actor, it affects the whole network (HPLE, 2014).

The number and name of the activities vary according to food type and production location. Thus, grouping food supply chains are convenient while explaining activities and actors. The food supply chain can be segmented into three parts according to activities which are upstream, midstream and downstream (Reardon, 2015). The upstream supply chain includes first and second-tier suppliers, who provide seeds, equipment, medicines and breeds for the producers, and agriculture farmers, animal farmers (Reardon, 2015). The initial production occurs at the upstream FSC. Midstream FSC includes activities of processing, wholesale and distribution (Reardon, 2015). The downstream food supply chain includes the activities of retailing, food service and consumption (Reardon, 2015). Further information about each segment in each segment is going to be provided in the next section.

2.1.1.1. Upstream food supply chain activities

2.1.1.1.1. Input supply

Like all other supply chains, FSC also starts with input suppliers, which are first-tier and second-tier and maybe third-tier suppliers. These suppliers provide equipment, seeds, medicines, breeds, land, technology, and all other relevant materials to perform food production. These suppliers help food production indirectly.

2.1.1.1.2. Food production

After input suppliers provide materials to producers, production starts. At this stage, raw materials are produced for selling or further processing. Raising livestock such as cattle and chicken, growing crops and farm fishing are all activities of food production. Suppliers provide raw food to processors.

Growing and raising food influence food availability and affordability (FAO, 2016). For each FSC, the name of the producer can be changed; however, their purpose is the same; to supply the raw food to processors while ensuring food security. For example, for agriculture food supply chain, the name of the producer is a farmer; while for the milk supply chain, the name of the producer becomes a dairy farmer. In a similar vein, for meat and poultry supply chain, the producer is named as animal farm/coop. Producers not only grow crops, herbs, vegetables, and fruits but also raise animal livestock, game fowl, and fisheries (Toka et al., 2016).

2.1.1.2. Midstream food supply chain activities

2.1.1.2.1. Processing and packaging

Processors manufacture raw products according to consumers' requests. Manufacturing processes include sorting, cleaning, cutting, boiling, refrigerating, freezing, grinding, crushing, drying, roasting, pasteurizing, vacuum packaging, adding salt, and or sugar, canning, and bottling (Moubarac et al., 2014).

The central role of food processing in the FSC is “adding value” to food products. At this stage, the transformation of food occurs considering the consumers' requests. This transformation can take place as either a packaging function or more complex issues such as transforming raw food to ready-to-eat meals. The primary purpose of the food processing are summarized as (Dani, 2015):

- To make food accessible when fresh food is not available

- To expand the life of products using appropriate techniques

- To enhance the variety of food products without losing nutritional value

- To make ready products for further processing

Milling, cooling or freezing, smoking, heating, canning, fermentation, and extrusion cooking are the main activities of the processing stage (Augustin et al., 2016). Food processing can change the nutritional value and functional properties, extend the shelf-life and improve the safety of food (High Level Panel of Experts - HPLE, 2017; Augustin et al., 2016; Weaver et al., 2014). Four categories exist for processing degrees which are unprocessed/minimally processed food, basically processed food, moderately processed food, and highly processed food (HPLE, 2017; Poti et al., 2015; Mounbarac et al., 2014). Unprocessed/minimally processed foods are the single foods that contain zero or very slight modifications such as milk, eggs, fresh meat, and fresh fish. Processed foods are the different foods that are isolated food components or modified foods with preservation methods such as sugar, oil, flour, unsalted canned vegetables, and unsweetened canned fruits. Moderately processed foods are single foods that included additional flavours such as salted nuts, canned in syrup, vegetables canned with added salt. Highly processed foods are foods that include multi-ingredient, industrially formulated mixtures such as pre-prepared mixed dishes, ready-to-eat cereals, salty snack, ketchup, margarine, and mayonnaise.

Moreover, perishable foods such as fruits, vegetables, and animal-sourced foods (ASF) are nutrient-dense. These type of products require cold chain storage and transport unless consumed within a short period or very close to the place of origin (HPLE, 2017). Thus, food processing also includes storing and packaging functions, as well (Dani, 2015).

The package is a material that protects the content or the product, keeps the product clean and safe, and enables storing the product until it reaches the final consumer (Taskin and Durmaz, 2012). So before transportation and storing foods, the finished foods need to be packaged. The packaging is used to present the product to the customer in a more attractive manner, providing information about the characteristics of the product and promoting the product (Koban and Yıldırım Keser, 2013). Besides, packaging helps to merge small pieces and together form more significant volumes.

2.1.1.2.2. Wholesaling

Since not all the food types can be grown each part of the world, however, the demand comes from the all over the world for all food types, after the manufacturing stage is completed, the processed food should be transferred to adjacent or distant markets where they are going to be consumed. Distributors enable the connection between producers, processors and markets. The physical logistics of the food are taken care of the distributors (Dani, 2015). They take both freshly produced food from the producers and processed foods from the processors and transmit them to markets via diverse channels. The importance of distribution activities increases especially in the case of global food supply chains since distributors need to deal with international and local regulations. Generally, distributors buy products in large quantities and handle and separate them in their infrastructure such as distribution centre, warehouse and dispatch them to be downstream of the supply chain whenever it is required.

2.1.1.3. Downstream food supply chain activities

2.1.1.3.1. Retailing

The retail stage enables various types of food products available in the stores. It is a highly competitive industry for both processors fight for the best shelves, and retailers compete with each other to get more customers. Consumers have different options for retailers, retailing channels and formats. Thus, retailers try to differentiate themselves consistently from their competitors with innovative business models. Big retailers procure the food directly from the manufacturers instead of buying from a wholesaler (Hulthen, 2010). This situation increased the power of retailers within the supply chain.

Recently, big retailers have been dominating the distribution and logistics of the food supply (Ge et al., 2019). Nevertheless, they are not conducting the whole distribution and warehousing functions by themselves. Instead, these functions have been operated by companies which are specialized in distribution and warehousing. The structure of food distribution for retailers has become more centralized. Retailers,

who want to get a discount from manufacturers during the procurement, prefer to order in high volumes. Moreover, to manage transportation costs, retailers tend to decrease the number of warehouses and store the food in distribution centres and ship directly to local retail stores (Chopra and Meindl, 2016).

2.1.1.3.2. Consumption

Consumption is the final yet the most critical stage of the FSC. It includes consumers with changing and challenging demands. Entire FSC tries to satisfy the consumers' needs and demands consistently. The prosperity of the FSC depends on the consumers and their buying habits. Consumers shopping and eating habits and perceptions about food affect the number of purchased products.

Food products are consumed not only at home but also in hospitality and food service sector. Hospitality and food service sector involve small and medium-sized enterprises which offer high value. Hospitality and food service sectors contain organizations that provide meals for out-of-home consumption (Martin-Rios et al., 2018). Hospitality and food service sectors include full-service providers (offer full table service, the central theme is the food), cafes/bars (the central theme is the beverages, generally offers different types of snacks), take-away & delivery (eating on site is not possible), fast food (focuses on serving quick, standardized food which is ordered, paid for and generally served at the counter), self-service cafeterias (located in corporate environments, schools, hospitals and offer different menus at a low price point), street stalls and kiosks (portable and small mobile outdoor or indoor outlets with a limited offer and a low price point) and event catering (Euromonitor International, 2016). These members take raw food materials and transform the food, considering the final consumers' requests.

2.1.1.4. Storing

Storing is also an essential activity in the FSC. Storing activities occur in both upstream, midstream and downstream FSC activities. All raw materials, semi-finished products and finished products are stored in storage units (warehouses). Raw materials

procured before the production process begins and they are kept in the warehouses until the production process starts. Similarly, finished products are held in the warehouses until they dispatch to consumers. Wholesalers and retailers keep products in their warehouses until the final customers buy them. Besides, warehouses are used to break high volume cargo into smaller volumes. On the other hand, products that are sent from different suppliers can be merged in the warehouses and shipped (Nebol et al., 2015). Notably, in the central retailer warehouses, different products shipped in high volumes broke into smaller volumes and merged with products came from different manufacturers and shipped to retailer stores.

Proper storing of food is essential not only because of the shelf-life concerns but also ensuring food security and hygiene. Perishable products have a short shelf life after harvested or produced. Thus, storing properly is essential for getting the benefits of the food products at the longest. Likewise, the storage unit (warehouse) must be in suitable conditions for ensuring hygiene and food security. Suitable conditions vary according to food type, yet the main requirements for almost all storage units are the same. The temperature of the warehouse should be arranged according to the type of product that needs to be stored. The storage unit should be designed for minimizing the contamination risks; storage units should not directly be exposed the sunlight. It should be moisture-free and bugs free.

2.1.1.5. Transportation

Raw materials (freshly harvested crops, raised livestock), semi-finished food products, and finished foods must be transferred to the next stages where the required operations will take place. Without transportation activities, none of the upstream, midstream and downstream activities can occur. Food supply chains expended all over the world. Thus, continuity of the food supply chains depends on transportation. The mode choice and temperature choice are important decisions that need to be taken in transportation. Generally, such decisions are determined according to food characteristics. For instance, food which has long shelf-life can be transported by road or sea transportation, on the other hand, perishable products need to be transported with air transportation due to short shelf life. Likewise, the required transportation

temperature regime affects transportation decision. If a product requires cool, cold or frozen temperature regime, the transportation unit has to be chosen, ensuring the required temperature. Otherwise, transporting in a transportation unit, which does not have temperature control, is acceptable.

The efficiency of the transportation and performance are affected by the following factors: distance, volume, characteristics of the products, frequency of the shipping, easiness of loading, handling opportunities, reliability and economic parameters (Gorcun, 2013). The cost/pricing of transportation depends on products' characteristics such as density, stability, ease or difficulty of handling and liability (Lambert et al., 1998).

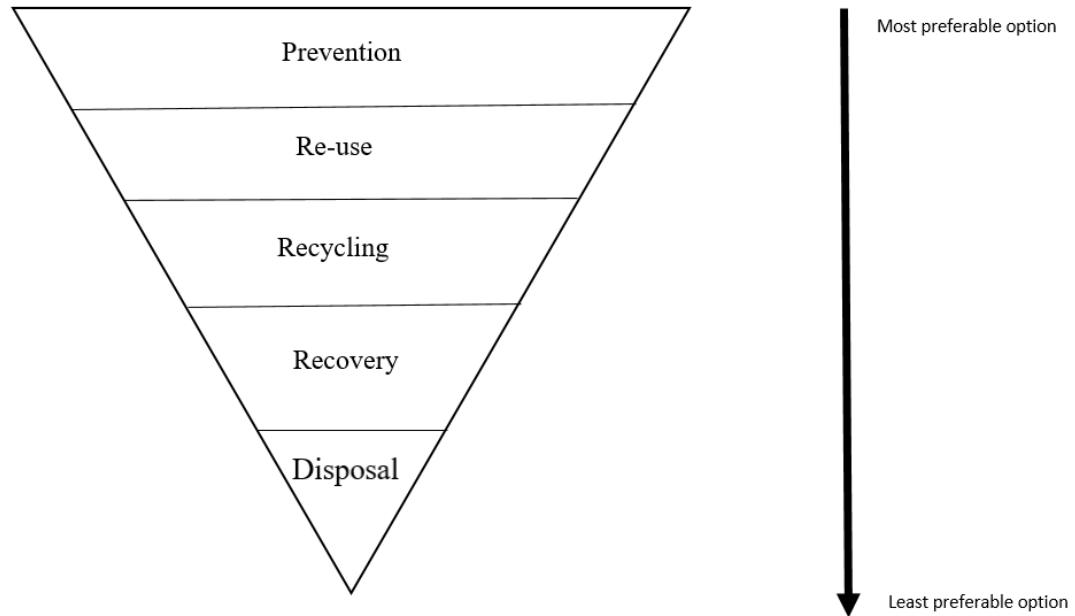
2.1.1.6. Managing waste

Waste management activities occur in upstream, midstream and downstream FSC activities. As it is mentioned at the beginning, each year, 1.6 tonnes of food becomes waste (FAO, 2020e), and handling this amount of waste in an environmentally friendly way is essential. While managing waste, the most commonly adopted approach is following waste hierarchy, which is officially introduced by the European Union Waste Framework Directive in 1975 (European Commission, 2020). Figure 5 shows the waste hierarchy framework.

The first stage of the waste management hierarchy is prevention. The primary purpose of this stage is to reduce or eliminate the waste of raw materials, ingredient or finished products. For achieving this purpose, avoiding food surplus and minimizing avoidable food waste are crucial (Papargyropoulou et al., 2014). This is also the preferable option (European Parliament Council, 2008).

The second stage is re-using. The primary purpose of this stage is to redistribute the surplus food, which is suitable for human consumption, to people who need the food. Different non-governmental organizations (NGOs) and food banks are involved redistribution of the food via redistribution networks (Papargyropoulou et al., 2014). Besides, if a product is not in a condition that can be consumed by a human due to various reasons such as passed expiry date or being contaminated, the product is used for animal feeding.

Figure 5: The waste management hierarchy



Resource: European Parliament Council, 2008

The third stage of the waste management hierarchy is recycling. Recycling stage includes transforming food waste into a new material or product, yet this option is only possible if the product's nature is available. The commonly applied approach in this stage is composting (DEFRA, 2011). With composting waste turns into valuable food for gardens and lands.

The fourth stage is the recovery. Anaerobic digestion and incineration of waste are commonly applied methods (Papargyropoulou et al., 2014). Anaerobic digestion is “the process by which organic matters is broken down to produce biogas and bio-fertilizer in the absence of oxygen” (NNFCC, 2020). Composting is a type of anaerobic digestion and adopted at homes for producing fertilizers. Incineration involves burning the waste to obtain energy, yet it is not an efficient way of obtaining energy (Papargyropoulou et al., 2014). Alongside inefficiency, it leads to environmental pollution as well, so it is a less preferred method.

The last stage is the disposal, which is the least preferred and most environmental unfriendly method. The waste is landfilled or thrown into the sewer, which leads to land, water and air pollution.

2.1.2. Food Characteristic

Different foods have different characteristics. It is essential to know the food's characteristics because decisions about transportation, storage, orders will be determined based on the features. The main food characteristics are perishability, variety, complexity, volume and fragility.

2.1.2.1. Perishability

A portion of food can be in one of the following categories; perishable, semi-perishable or non-perishable. Critical decisions are determined according to perishability level of the food. The perishability level of food is essential since transportation and storing decisions are determined based on the perishability level. The transportation mode selection, the speed and temperature selections are based on the perishability level of the food. The storage conditions of the foods will be decided based on the perishability level of the food. Shelf life is the main criteria while identifying a product, whether perishable or non-perishable (van Donselaar et al., 2006).

If the food is perishable, the shelf life of the product becomes dependent on the technologies of refrigeration, drying freezing, canning and the use of chemical preservatives. If the food is considered as non-perishable, then the purpose of storing becomes preserving the food, including preventing the food from insects, rodents and keeping the food dry.

Perishability affects all types of foods, including fresh products (WRAP, 2012; Price et al., 1996). All raw materials, semi-finished products and finished products have a different perishability duration (Browne and Allen, 1998; van Donk, 2000; van der Vorst et al., 2005). For example, since fruits and vegetable products are highly perishable, they need to deliver to point-of-sale as soon as possible, meaning that during the transportation of perishable products, fast transportation modes must be

used. Moreover, to slow down the spoilage, perishable products should be transported and stored within a cold chain. Nevertheless, for a non-perishable product such as nuts, slower transportation modes can be chosen.

2.1.2.2. Variety

The product variety is another important characteristic of food. Customers have become more demanding in terms of product varieties (van Donk, 2000; van der Vorst et al., 2005; Ferguson and Ketzenberg, 2006). They request fresh foods with diversity in good quality with a modest shelf life (Smith and Sparks, 2004). Moreover, this is not only true for branded products but also private labelled products (Berges-Sennou et al., 2004). The variety includes size, taste, flavour, freshness, quality, and integrity of the product.

2.1.2.3. Complexity

The complexity level of food is another crucial food characteristics. The level of complexity is determined based on the number of processes that the food is passed. The processes include sorting, sizing, packaging, labelling, manufacturing, freezing and similar stages as well. The complexity level ranges between relatively simple and standards (such as bananas, apples) to highly complex (such as ready-to-eat meals) (van der Vorst et al., 2007). Some of the food only requires packaging, while others require high processing. Also, deciding how to transport foods, considering the temperature requirements also increase the complexity level. For example, the foods which require frozen transportation or cold transportation cannot be shipped in the same transport unit although they come from the same source. Moreover, the complexity issue is not only related to the supply chain activities, but also hygiene and safety standards as well.

2.1.2.4. Volume and weight

Generally, foods are produced in large amounts and sold in smaller quantities (van Donk, 2000; van der Vorst et al., 2005; van Donselaar et al., 2006). This situation necessitates having different handling equipment at the same time for large and small

volumes, and a place where big volume products will be spared to lower volumes, meaning that quantity of the food affects the logistics activities. Similarly, the weight of food has also impact on the food's logistics activities.

Both the volume and weight of the products are essential characteristics for the logistics activities. For example, during the transportation of low volume-to-weight ratio products, carrying capacity of a vehicle, handling capacity and storage space will be fully utilized. Nevertheless, for the products with high volume-to-weight ratio, they underutilize the vehicle/ handling equipment because they will occupy more space (Browne and Allen, 1998).

2.1.2.5. Fragility

The fragility of products is another critical characteristic of food. Handling and packaging decisions are taken based on the fragility level of the products (Browne and Allen, 1998). If a food product is fragile such as dried fruits, they need to handle and transport extra caution. Because even small fractions cause value decrease for such products.

2.1.3. Food Constraints

In a food system, actors have to consider food constraints and arrange the whole processing, transportation, and selling activities considering the limitations. The main food constraints are short shelf-life, temperature sensitiveness, spoilage or deterioration, climate effects and uncertain demand and supply.

2.1.3.1. Short-shelf life

Shelf life is defined as *“the length of time a food can be kept understated storage conditions while maintaining its optimum safety and quality”* (EUFIC, 2013). Shelf life begins when a product is harvested or is processed. Processing type, exposing the sunlight the materials used for packaging, level of humidity, storing

conditions and used ingredients during the processing affect the shelf life of a product (Lawrie, 1998).

A product's shelf-life is stated either best-before date or use-by date. Best-before date is defined as *"the date until which a foodstuff retain its specific properties when the product has been stored appropriately and the package unopened."* (European Parliament & Council of the European Union, 2000). Best-before date mainly implies the date when the quality of food is guaranteed instead of indicating food safety (Adam, 2015). Use-by-date is primarily preferred to use in perishable foods. Because after a short period, food safety cannot be guaranteed (European Parliament & Council of the European Union, 2000).

After the processing activity is completed, the rest of the all movements has to be conducted considering the shelf life of the product, i.e., distribution of the finished products must be fast for short shelf-life products.

2.1.3.2. Temperature sensitiveness

Temperature conditions during food production, transferring, and storing are the critical factors that affect the spoilage process. The reason for microbiological food spoilage is the microorganisms such as bacteria, yeasts and moulds (Petruzzi et al., 2017). Microbes are highly active in certain temperatures, especially between 7°C - 63°C. However, the optimum temperature differs for each type of microorganism (Hart, 1998). As the heat moves from this range either above or below, the activity rate of growth will decrease. Thus, to slow down the degradation, foods must be processed, stored and transferred within low temperatures.

2.1.3.3. Spoilage or deterioration

Food spoilage can be defined as *"a process or change which renders a product undesirable or unacceptable for consumption"* (Nychas and Panagou, 2011). Deterioration is a result of microbiological, chemical, or physical changes in the product (Petruzzi et al., 2017). Microorganisms are the cause of microbial spoilage. Chemical deterioration is a result of either different components of foods reacting with

each other or added components changes the food's characteristics (Petruzzi et al., 2017). Physical deterioration is a result of either the dried foods get too much moist or moist food get dehydrated (Benner, 2014).

Change in the colour, texture, unwanted tastes and unpleasant smell are some of the indicators of spoilage. The food industry continually takes precautions against these reactions by applying different methods such as adding preservatives, keeping the food at a lower temperature, packaging properly, storing inappropriate conditions etc.

2.1.4. Food Security

Food security concept emerged during the mid-1970s during the global food crisis (Clay, 2002). The scope of food security has been changing over time. In the 1970s, the primary purpose of food security was to produce more food and distribute it better to the world population. In contrast, today, the use of food security involves availability, access, utilization and stability of the food (FCRN, 2018). The evolution of food security definitions is shown in Table 2.

Table 2: Definitions of Food Security over Time

Institution Year	& Definition
FAO, 1974	<i>“availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices.”</i>
FAO, 1983	<i>“ensuring that all people at all times have both physical and economic <u>access</u> to the basic food that they need.”</i>
FAO, 1996	<i>“Food security exists when all people, at all times, have physical and economic access to sufficient, <u>safe and nutritious</u> food to meet their dietary needs and <u>food preferences</u> for an active and healthy life.”</i>
FAO, 2002	<i>“Food security [is] a situation that exists when all people, at all times, have physical, <u>social</u> and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.”</i>

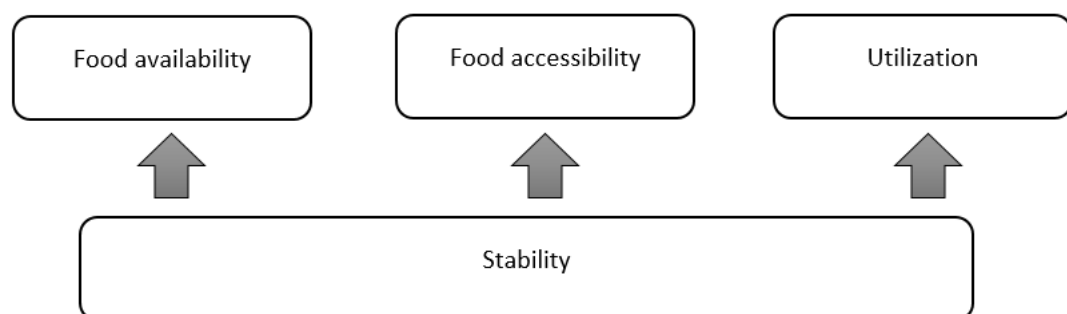
Resource: Compiled by author (adapted from Clay, 2002)

The emphasis of the first definition was on the volume and stability of food suppliers. Later, the food security concept was widened to ensuring equality between supply and demand specifically considering vulnerable people's accessibility to available supplies. Before the following definition was proposed, food security was accepted as a global concern, not only individuals' problems. Also, the definition was included safety and nutritional requirements and food preferences based on culture and social norms. In the recent definition, alongside the prior adding, emphasis on social consumption was added.

When food security cannot be achieved, food insecurity occurs. Food insecurity is defined as *“a situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and active and healthy life”* (FAO, 2015).

Four pillars need to be ensured to achieve food security in food systems. The pillars are food availability, food access, food utilization and stability (CFS, 2014). These pillars support each in harmony. Figure 6 shows the four pillars of food security.

Figure 6: Four Pillars of Food Security



Resource: FCRN, 2018

Food availability is defined as *“sufficient quantities of food of appropriate quality, supplied through domestic production or imports, including food aid”* (FAO, 2011a). In the 1970s, food availability was the only indicator of food security. It was believed that people were food insecure because food production was not enough. However, it has been realized that problem was not only on the production but also in the distribution and exchange (Gregory et al., 2005). The production capacity depends on soil management, land utilization and ownership, harvesting technique, weather,

seed, utilization of pesticide, breeding, livestock breeding and management (FAO, 2013; Gregory et al., 2005). Food distribution is related to storage, processing, transportation, packaging and marketing (FAO, 1997). Food distribution is also affected by the employed technology, logistical infrastructure and equipment.

The population depends on food, thus to get food, the exchange, bartering or cash economy becomes a requirement (Gregory et al., 2005). Ensuring such system requires working market institutions, and efficient trading systems (Ecker and Breisinger, 2012). For having a healthy life, a woman needs to take 1,600 – 2,400 calories per day; while a man needs to take 2,000 - 3,000 (Dietary Guidelines, 2015). When the per capita calorie supply is examined across the nations Europe, Oceania and North America have per capita supply more than 3100 kcal/person/day. On the other hand, South Asia, Sub-Saharan Africa and South America have per capita supply between 2,300 - 3,000 kcal/person/day (Roser and Ritchie, 2013). According to these statistics, per capita world supply is adequate for food security across the world. Nevertheless, food insecurity comes up as a result of problems in the distribution.

Food accessibility is related to physical and economic access to food, including the preferences of individuals and households (Gregory et al., 2005; Charlton, 2016). Food accessibility is defined as “*the household’s ability to acquire adequate amounts of food through own production and stocks, purchases, barter, gifts, borrowing and food aid*” (WFP, 2009). Affordability, allocation and preference are the three elements of food access (Gregory et al. 2005). Affordability is related to economic condition. Household income level must be enough to buy food to feed themselves, or the household has enough land to grow food to feed themselves (Garrett and Ruel, 1999). Allocation is related to transporting food from the source of origin to the consumption point (Napoli, 2011).

Preference is mostly related to socio-cultural factors. Although there can be enough amount of food from different sources, and households have enough income to buy, consumption preferences based on cultural or religious factors still play a significant role in food accessibility. If an individual or household cannot consume a type of food because of religious reasons, while food is available, this means that still there is a food accessibility problem occurs (Napoli, 2011; Gregory et al., 2005).

Food utilization is related to nutritional and societal values and safety (Gregory et al., 2005). Food utilization is defined as “*the proper biological use of food, requiring a diet providing sufficient energy and essential nutrients, potable water and adequate sanitation*” (Rivera and Qamar, 2003). Food utilization is used interchangeably with malnutrition (food nutrition), yet it is not just about malnutrition. Alongside malnutrition, food utilization is also about having clean water and sanitary facility, the health of individuals, and food safety and hygiene (Charlton, 2016). Food availability and having access to food are not enough for food security. The consumed food also needs to be safe and nutritious (Napoli, 2011). Calorie intake and nutrition value of the food are not the same things. Thus, having nutritious food is also essential while ensuring food security (Gregory et al., 2005). Likewise, clean water and having sanitary facilities for FSC activities are also vital for ensuring food security (Napoli, 2011).

Although an individual consumes a food, if there is an underlying condition for individual, which leads to digestive problems, food utilization cannot be achieved. Thus, having a healthy individual and healthcare systems are essential pre-conditions for food utilization (Rivera and Qamar, 2003). Food safety mainly tries to eliminate the food-borne disease. If consumers mishandle the food, prepare erroneously or store in wrong conditions, the possibility of getting sick from these food increases. Thus, food safety deals with these wrong applications and eliminates food-borne disease. (Hygiene Food Safety, 2019).

Food stability is related to the ability to obtain food at all times. For instance, if an individual intakes adequate amount of food today (in terms of calories and nutrition), but the individual is not sure if he/she gets food for the next day, that individual still considered as food insecure. Sudden shocks (environmental crisis, disasters or pandemics), cyclical events (seasonal food insecurity) and economic conditions (income level of household or price volatilities) affect food stability (FAO, 2006; Charlton, 2016). For instance, according to the United Nations’ World Food Programme (WFP), COVID-19 pandemic could double the number of people who suffers from food insecurity (WFP, 2020). In conditions where food insecurity reoccurs frequently, it is considered as seasonal food insecurity (Food Climate

Research Network - FCRN, 2018). Price instability is another problem while achieving food stability.

Next section provides more information about the encountered challenges while trying to achieve food security.

2.1.5. Challenges to Achieving Food Security

Global food security deals with various challenges from both the production and consumption side. Climate change, water scarcity, soil degradation and biodiversity loss are the main challenges from the production side, on the other hand, population growth, consumption patterns, food loss and food waste are the main challenges from the consumption side (Global Food Security, 2017).

2.1.5.1. Climate change

Human activities have an essential impact on Earth's climate. Since the beginning of the industrial revolution, the ratio of carbon dioxide (CO₂) has increased by 50% while the methane (CH₄) has increased about 259%, and nitrous oxide (N₂O) has risen 20% (McGrath, 2019; Global Change, 2020). These gases are called greenhouse gases (GHG), and the level of GHG is at its highest amount in the last 800,000 years (Nunez, 2019). However, the high amount of GHG around the world leads to global warming, and global warming is one of the significant triggers of climate change.

Climate change shows up not only as an increase in temperature but also abrupt weather conditions such as storms, hurricane or flood and natural events in regards to geography. The temperature rises, weather conditions and natural events affect food security from different angles from production to market changes, price volatility and supply chain infrastructure at the global, regional and local level (Gregory et al., 2005; EPA, 2016). Four pillars of the food security will be affected by climate change, and it will be observed as a risk in food availability, a reduction in accessing food and a fall in food quality, and instability of supplying food (Tandon et al., 2017).

Increase or decrease in the temperature makes difficulty for crops production. Each crop requires certain temperatures for growing, abrupt changes in the temperature or unexpected rains, cold or hot weather can destroy the whole crops. Moreover, storms, hurricanes or floods can damage the supply chain infrastructure, which leads to delays or no delivery of the food to consumption points at all. Both these incidents unbalance food supply and demand, which causes price volatility in the market.

2.1.5.2. Water scarcity

Although 70 percent of Earth is covered with water, solely 3 percent is considered as freshwater meaning that it can be used for drinking, cleaning, and food growing purposes. Freshwater sources are rivers, lakes, aquifers and ground waters. Water is a key component while ensuring food security. Agriculture is the biggest user of Earth's available freshwater. 70% of the freshwater pull-outs are used for agricultural purposes (FAO, 2017). Irrigation is an essential part of agricultural production. However, the source of freshwater dry up and levels of them fall (U.S. Geological Survey - USGS, 2020).

Water scarcity severely affects food security, specifically food availability and utilization of food. If there is not enough clean water source, then food production will stop or will be significantly reduced. This situation will lead to an unbalance of supply, and the price of the food will increase. Moreover, as it is explained in the utilization of food, to be considered as food secure, individual should be in a health condition that his/her body digests the eaten food. Deprivation of clean water leads to severe and irrevocable illness on the human body.

2.1.5.3. Soil degradation and biodiversity loss

95 % of food production is dependent on soil (Ritchie and Roser, 2019). Soil degradation is defined as “a change in the soil health status resulting in a diminished capacity of the ecosystem to provide goods and services for its beneficiaries” (FAO, 2020c). Soil degradation affects food availability, food utilization and stability. According to FAO (2020d), soil degradation affects almost 50% of crop growth.

Moreover, the food which grows in degraded soils will be less nutritious, smaller and tend to be more misshaped (FAO, 2020d). Producing less food, as a result of soil degradation negatively affects the food supply. Moreover, diminishing the nutritional value of the food means that individuals need to consume more food to ensure they take the required calories and nutritional values each day. Likewise, stability will be jeopardized since the production level, and nutritional level of the food significantly decrease as a result of soil degradation.

For food production, biological diversity is essential (FAO, 2004). Biological diversity includes not only a variety of types but also generic variations as well. Biological diversity threatens food availability. 90 % of animal-based nutrition is supplied from 14 mammals and bird species; while more than 50 % of plant-based nutrition comes from 4 species (wheat, maize, rice and potato) for human consumption (FAO, 2004). When farmers do not give importance to diversity, and varieties, species become endangered, and gene pool diminishes significantly (FAO, 2004). According to FAO (2008), three-quarters of all agricultural biodiversity has been lost, because the farmers tended to grow standardized crops. While the expectations for the population will reach 9.8 billion, the food system will more need food types to feed the whole population. Thus, protecting species and varieties have importance to ensure food availability and food security.

2.1.5.4. Population growth and changing consumption patterns

Although food system produces enough food to feed the entire population (7.7 billion people), currently 820 million people were food insecure. Estimates show that world population will reach 9.8 billion in the year 2050. This increase will raise the pressure on the food systems. Thus, the increasing population will affect food security.

Generally, food is produced in rural areas and consumed in urban areas (Satterthwaite et al., 2010). The urban population regularly increases (World Health Organization - WHO, 2019). According to the UN, in 2018, 55 % of the world's population resides in urban areas, and it is expected to reach 68% in the year 2050 (UN, 2018). Since the areas used for agricultural purposes started to be used for non-agricultural purposes such as constructing a factor or building, the agricultural

land amount diminishes. Parallel to population increase, people started to prefer to live in urban areas. This decision means that fewer people will live in rural areas, and the workforce available for farming and agriculture will be less. If the supply diminishes, the price of the product increases. Thus, we can infer that urbanization will have a negative impact on food availability and food accessibility.

In the last century, the overall income level of people increased all around the world (Gapminder, 2019). Almost all over the world, daily earnings per person is doubled (Gapminder, 2019). The changes in the income level have affected on the dietary habits as well (Muhammad et al., 2017). Tukker et al. (2010) mentioned that the more wealth of household increases, the more food is consumed by the household. Currently, meat production has been increased four/five times compared to fifty years ago (Ritchie and Roser, 2019).

Similarly, milk consumption also doubled as the income level has increased (Ritchie and Roser, 2019). Today most of the grain is used for animal feeding while in the past, grain was consumed by people (Guyomard et al., 2013). Thus, these changed eating patterns also increase the pressure on the food system.

Moreover, demographic changes, such as the number of people living in the household, employment status of the household, affect the food consumption pattern. Larger households buy more food than smaller households (Willersinn et al., 2015; Stancu et al., 2016; Grainger et al., 2018b). Similarly, in today's world, both women and men have jobs and prefer to eat ready-to-cook or ready-to-eat food. Thus, ensuring food security considering demographic changes is another critical issue.

2.1.5.5. Food loss and food waste

Each year 1.6 billion tons of food become wasted (FAO, 2020e). This amount is enough to feed the whole hungry people in the world (FoodShare, 2020). However, while conducting activities of FSC, due to various reasons, food becomes a loss. In most cases, wasted food is in perfect condition for human consumption, but it is still wasted. Thus, food loss is a significant threat to food security (The Economist Intelligence Unit - EIU, 2014).

In the literature, it has been observed that the concept of food loss and food waste were used interchangeably (Lipinski et al., 2013; FAO, 2014; HPLE, 2014; Verghese et al., 2015; Okawa, 2015; Shafiee-Jood and Cai, 2016; Sheahan and Barrett, 2017; Salihoglu et al., 2018). However, the extent of the food loss and food waste differs according to where the loss occurs and development levels of the countries (Parfitt et al., 2010; Buzby and Hyman, 2012; Adam, 2015; Alamar et al., 2018; COMCEC, 2017).

Food loss is mainly related to more technical issues such as poor farming and harvesting technologies, poor storage infrastructure, poor transportation network, poor market conditions, lack of coordination (Godfray et al., 2010; Gustavsson et al., 2011; Aschemann-Witzel et al., 2017). Food waste is more related to behavioural issues and mainly observed at out-of-home consumption points and households (Graham-Rowe et al., 2014; Thyberg and Thonjes, 2016).

Besides, in the literature, the investigated stages of FSC also impacts the utilization of the concepts. “Food loss” concept is mainly used to identify the loss occurred before the food is reaching the consumer; while “food waste” concept is employed to define the loss which occurred at food services and consumers (Parfitt et al., 2010; Gustavsson et al., 2011; Tatlidil et al., 2013; Aschemann-Witzel et al., 2015; Secondi et al., 2015; Teuber and Jensen, 2016).

According to Tatlidil et al. (2013), the food loss mainly occurs during agricultural production, postharvest handling and storing, processing and packaging, distribution; while the food waste mainly occurs at the consumption stage. Table 3 shows food loss and food waste percentages for certain product groups.

Table 3: Food Loss and Food Waste Percentage for Product Groups at Different Stages

	Agricultural production	Postharvest handling and storing	Processing and packaging	Distribution	Consumption
Cereals	5.1%	4%	2%	1%	5%
Roots and tubers	7%	6%	2%	3%	2%
Oilseed and pulses	15%	5%	7%	1%	4%
Fruit and vegetables	2%	8%	10%	10%	5%
Meat and poultry	10%	0.2%	5%	0.5%	1%
Milk and dairy products	10%	1%	1.5%	6%	1.5%

Resource: Tatlidil et al. 2013

Although it is clear that loss and waste occur at each stage, it can be stated that the occurred loss amount is higher at the upstream FSC compared to downstream FSC (Tatlidil et al., 2013). Thus, the food loss concept is going to be employed for the rest of the thesis. Further information about food loss is going to be provided in the next section.

2.2. FOOD LOSS

2.2.1. Definition of Food Loss

No consensus has been reached to identify food loss. Different definitions can be adapted while tackling the phenomenon. Table 4 shows the major food loss definitions employed by the studies.

Table 4: Major Food Loss Definitions

Reference	Definition of food loss
FAO, 1981	<i>“wholesome edible material intended for human consumption arising at any point in the food supply chain that is instead discarded, lost, degraded or consumed by pets.”</i>
Grolleaud, 2002	<i>“ decrease in food quantity or quality, which makes it unfit for human consumption.”</i>
Gustavsson et al., 2011	<i>“decrease in edible food mass throughout the part of the supply chain that specifically leads to edible food for human consumption.”</i>
Buzby and Hyman, 2012	<i>“a subset of postharvest losses (or post-production) and represents the edible amount of food available for human consumption but is not consumed.”</i>
Beretta et al., 2013	<i>“food which is originally produced for human consumption but then directed to a non-food use or waste disposal (e.g. feed for animals, biomass input to a digestion plant, disposal in a municipal solid waste incinerator)”</i>
FAO, 2013	<i>“a decrease in mass or nutritional value of food originally intended for human consumption, usually caused by inefficiencies in the FSC (poor infrastructures and logistics, lack of technology, insufficient skills, knowledge, and management capacity of supply chain actors and lack of access to markets)”</i>
Lipinski et al., 2013	<i>“spills, spoils, incurs an abnormal reduction in quality such as bruising or wilting or otherwise gets lost before it reaches the consumer.”</i>
HPLE, 2014	<i>“a decrease, at all stages of the food chain prior to the consumer level, in mass, of food that was originally intended for human consumption, regardless of the cause.”</i>
FAO, 2019a	<i>“is the decrease in the quantity or quality of food resulting from decisions and actions by food suppliers in the chain, excluding retailers, food service providers and consumers.”</i>

Resource: Compiled by author

As it can be observed from the table, different definitions can be utilized while defining food loss. In this thesis, FAO (2019a)’s definition is employed while identifying the scope of the thesis. According to this definition, not only quantity loss but also quality loss are considered as food loss. Moreover, according to this definition,

the loss occurred at the retailer, food service providers and consumers are not considered as food loss. The loss occurs at these three stakeholders are considered as food waste (FAO, 2019a). In the next section, more information about stakeholders who deal with food loss, and the reasons for the food loss is going to be provided.

2.2.1.1. Stakeholders who deal with food loss

FSCs consist of different activities which are conducted by various stakeholders. For instance, farmers, ranchers, aquaculture, plantations, stockbreeder, sheep and goat breeder, greenhouse gardener and community gardeners are some of the stakeholder groups observed in the production stage (United States Environmental Protection Agency - EPA, 2020). Food processing stage includes food manufacturers and food processors (EPA, 2020). On the other hand, wholesaling, retailing and food servicing stage include wholesalers, retailers, vendors, grocers, convenient markets, traditional markets, bazaars, butchers, fishmongers, cafeterias, restaurants, food pantries, and food banks (EPA, 2020). Similar to other stages, consuming stage includes different stakeholders such as individual consumers or groups, soup kitchens, food banks, schools/institutions, faith-based organizations, non-profit organizations (EPA, 2020). As it is explained in earlier sections, waste management is a crucial stage which has different stakeholders such as composters, industrial users, animal feed operators, facilities where anaerobic digestion can be conducted (EPA, 2020). Besides, FSCs were not solely consisted of these stakeholder groups. Policymakers or regulators, such as federal, local, state government and non-governmental organizations are indispensable stakeholders in the FSC (EPA, 2020).

As it is defined by FAO (2019a), food loss occurs in the FSC stages except for retail, and consumption, including food services (out-of-home consumption point) and individuals and households. The definition implies that not all stakeholders deal with food loss equally. The definition of food loss sets boundaries which stakeholders deal with food loss and which stakeholders deal with food waste. Considering FAO (2019a)'s definition, it can be inferred that food loss occurs at the upstream and midstream food supply chain, while food waste occurs at the downstream food supply chain (FAO, 2011b; FAO, 2019a; Surucu Balci and Tuna, 2020).

Although this inference can be made in regards to food loss definition, it is not clear that specifically which stakeholders deal with food loss or in other words which stakeholders have more salience while dealing with the food loss. It is essential to understand whether food loss drivers (reasons) change according to stakeholders while offering solutions. Thus, identifying and classifying stakeholders who are salient while dealing with food loss is crucial. For this purpose, one of the objectives of this thesis is to identify and classify critical upstream and midstream stakeholders (CUMSs).

2.2.1.2. Drivers of food loss

The significance of food loss is unequivocal, and loss occurs due to various drivers (reasons). The loss drivers vary due to different factors such as food characteristics, food constraints; activities take place in the FSC and stakeholders in the FSC. There are plenty of studies were conducted to identify the reasons for food loss, but they focused on different segments of the SC and for food groups. These studies can be summarized as follows:

To identify drivers for downstream food supply chains, lots of studies were conducted for general food types including fruit and vegetable, milk and dairy, meat and sausages, fats and oil and bakery products (Tromp et al. 2016; Kliaugaitė and Kruopienė, 2018; Teller et al. 2018; Falasconi et al. 2015; Wilkie et al. 2015; Derqui et al. 2016; Heikkilä et al. 2016; Farr-Wharton et al. 2014; Silvennoinen et al. 2014; Aschemann-Witzel et al. 2015; Aschemann-Witzel et al. 2018; Chakona and Shackleton, 2018; Grainger et al. 2018a; Juvan et al. 2018).

To identify food loss drivers for midstream supply chain, a limited number of studies were conducted. Mena et al. (2011) conducted a study to identify food loss drivers for ambient, chilled and frozen food groups. Raak et al. (2017) conducted a study to identify food loss drivers for bakery products, convenient foods, dairy products, fruit and vegetables, meat and sausage and sweets and snacks.

To identify food loss drivers for the upstream supply chain, a limited number of studies were conducted. Chauhan et al. (2018) and Campbell and Munden-Dixon (2018) investigated food loss drivers at the upstream supply chain.

Generally, studies conducted for the downstream food supply chain were not focused on any specific food types. At the same time, some of the studies conducted for identifying food loss drivers for upstream and midstream supply chain were mainly focused on specific food types such as fruit and vegetable, meat and sausage or dairy products. However, it is apparent that the number of conducted studies for upstream and midstream are inadequate compared to studies conducted for downstream.

Furthermore, conducted studies investigated all food loss drivers. Production technologies related reasons, appearance-related reasons, packaging related reasons, behaviour and consumer habits related reasons, and logistics-related reasons were identified in the same studies (Beretta et al., 2013; Göbel et al., 2015; Priefer et al., 2016; Canali et al., 2017). Each of these drivers is essential while tackling with food loss, and, in the literature, there are studies which are focused specifically to identify and offer solutions to a particular type of food loss drivers such as production technology (Radzevicius et al., 2015; Greeley, 2019) product appearance (de Hooge et al., 2017), packaging (Williams et al., 2012; Wohner et al., 2019; Wikström et al., 2019) and consumer behaviour and habits (Grandhi and Singh, 2016; Lanfranchi et al., 2016; Porpino, 2016).

Although logistics-related reasons were identified as one of the food loss drivers, to the best of the authors' knowledge, none of the studies was identified as food loss drivers from a logistics perspective. Only Liljestrand (2017) offered logistics related solutions to food loss drivers which were identified by Mena et al. (2011). However, drivers, which were identified by Mena et al. (2011) -megatrends, natural constraints and management root causes- were not determined from the logistics point of view. Liljestrand (2017)'s study; the author provided logistical solutions where possible. Liljestrand (2017) stated that further studies are required to identify loss drivers from the logistics point of view to diminish food loss in the FSC. For this purpose, one of the objectives of this thesis is to identify and classify logistics-related critical food loss drivers (LCFLDs). However, the identification and classification of the LCFLDs are not enough. It is important to offer solutions to diminish food loss amount. Thus, after identifying and classifying the food loss drivers, it is essential to specify which of the LCFLDs cause more loss in the FSC. For this purpose, identified LCFLDs are going to be prioritized.

2.3. SUMMARY

This chapter provides information about global food systems and factors which make the system complex such as food characteristics, food constraints and ensuring food safety. Food is a vital source for human life, and each person has food security right (FAO, 2006). However, issues such as climate change, water scarcity, soil degradation and biodiversity loss, population growth and changing consumption patterns and food loss and food waste endanger food security. According to a recent FAO report, each year, 1.6 billion tonnes of food become loss (2020e). The lost amount is enough for to feed two times hungry people all around the world (FoodShare, 2020), which means that with only eliminating food loss and food waste, food security can be assured.

According to recent definitions, when the food turns into waste at the upstream and midstream supply chain, it is considered as food loss (FAO, 2019a). While the food turns into waste at the downstream supply chain, it is considered as food waste (FAO, 2019a). Food waste is more related to individual behaviours and consumption patterns, whilst food loss deals with poor infrastructure and logistics, lack of technology, and organizational capabilities. While both food loss and food waste are crucially important while ensuring the food security, in the literature, majority of the studies addressed the food waste issue for retailing, and consumer stages for developed country context, much fewer studies addressed the food loss issue for the first stages of the FSC for developing country context (Xue et al., 2017). Thus, to contribute to the literature, this thesis aims to reduce food loss to enhance food security within the food supply chains with the logistics viewpoint.

CHAPTER III

THEORETICAL FRAMEWORK OF THE STUDY

3.1. THEORETICAL BACKGROUND OF THE STUDY

The theoretical underpinning of this thesis was ensured with the utilization of the stakeholder identification and salience theory (SIST) and theory of critical success factors (TCSFs). In this chapter, further information in each theory is provided.

3.1.1. Stakeholder Identification and Salience Theory

In today's world, the relationship between the organizations and their environments become more robust compared to the past. Making a profit and increasing wealth of owners were the main objectives of any organizations in the past. Moreover, having a robust financial structure was considered a success for the firms. According to classic organization theories, the primary purpose of an organization was to increase the profits by effectively using its resource and keep the organization in the game as long as possible while increasing the wealth of shareholders by maximizing the return on investments of business owners (Friedman, 1962).

However, a new perspective (stakeholder theory) appeared recently and widely applied. This perspective proposes that firms should protect not only the shareholders' interests but also suppliers, employees and local communities' interests (Freeman, 1984). According to this perspective, organizations gain a competitive advantage as much as they give importance to their environments. In other words, organizations should not only take into consideration of groups, whose benefits can be affected by the act of organization but also creates value for these groups (Freeman et al., 2010). In this perspective, identifying groups and creating values have vital importance for the survival of the organization. However, identifying and prioritizing stakeholders are quite complex tasks (Best et al., 2019) and stakeholder theory falls short of achieving it (Ambler and Wilson, 1995; Donaldson and Preston, 1995; Cummings and Patel, 2009; Mitchell et al., 1997; Wood et al., 2018). Thus to overcome this problem, stakeholder identification and salience theory (SIST) can be utilized (Mitchell et al.,

1998; Neville and Menguc, 2006; Wood et al., 2018). In the next section, further details about the theory is going to be provided.

3.1.1.1. The concept of stakeholder

Although the research about stakeholders in organizations have accelerated in mid-1980, the roots of the stakeholder concept go back to 1960s. The word “stakeholder” first appeared in an internal memorandum at the Stanford Research Institute (SRI) in 1963 (Freeman, 1984). Following the definition of SRI, many other definitions have been proposed. In the literature, there had been a long debate about setting bounds to the stakeholders. While some of the researchers put the limits of the stakeholder definition narrowly (Clarkson, 1994), some of them defined the stakeholder extensively (Freeman and Reed, 1983; Freeman, 1984). Table 5 shows attempts to define stakeholder.

Table 5: The Definitions of Stakeholder

Author(s)	Definition
SRI, 1963	<i>“those groups without whose support the organization would cease to exists” (cited in Freeman & Reed, 1983 and Freeman, 1984)</i>
Freeman and Reed, 1983	Wide: <i>“can affect the achievement of an organization’s objectives or who is affected by the achievement of an organization’s objectives.”</i> Narrow: <i>“on which the organization is dependent for its continued survival.”</i>
Freeman, 1984	<i>“can affect or is affected by the achievement of the organization’s objectives.”</i>
Freeman and Gilbert, 1987	<i>“can affect or is affected by a business.”</i>
Cornell and Shapiro, 1987	<i>“claimants” who have “contracts.”</i>
Evan and Freeman, 1988	<i>“have a stake in or claim on the firm.”</i> <i>“benefit from or are harmed by, and whose rights are violated or respected by, corporate actions.”</i>

Alkhafaji, 1989	<i>"groups to whom the corporation is responsible."</i>
Carroll, 1989	<i>"assets to have one or more of these kinds of stakes."</i> <i>"ranging from an interest to a right to ownership or legal title to the company's assets or property."</i>
Goodpaster, 1991	<i>"one with a 'stake' in the game is one who plays and puts some economic value at risk."</i>
Savage et al., 1991	<i>"have an interest in the actions of an organization and .. the ability to influence it."</i>
Hill and Jones, 1992	<i>"constituents who have a legitimate claim on the firm... established through the existence of an exchange relationship" who supply "the firm with critical resource and in exchange each expects its interests to be satisfied."</i>
Brenner, 1993	<i>"having some legitimate, non-trivial relationship with an organization (such as) exchange transactions, action impacts, and moral responsibilities."</i>
Carroll, 1993	<i>"asserts to have one or more of the kinds of stakes in business" – may be affected or affect...</i>
Freeman, 1994	<i>Participants in "the human process of joint value creation."</i>
Wicks et al., 1994	<i>"interact with and give meaning and definition to the corporation."</i>
Langtry, 1994	<i>The firm is significantly responsible for their well-being, or they hold a moral or legal claim on the firm</i>
Clarkson, 1994	<i>"bear some form of risk as a result of having invested some form of capital, human or financial, something of value, in a firm."</i> <i>"are placed at risk as a result of a firm's activities."</i>
Clarkson, 1995	<i>"have or claim, ownership, rights, or interests in a corporation and its activities."</i>
Brenner, 1995	<i>"are or which could impact or be impacted by the firm/organization."</i>
Donaldson and Preston, 1995	<i>"persons or groups with legitimate interests in procedural and/or substantive aspects of corporate activity."</i>
Eden and Ackermann, 1998	<i>"people or small groups with the power to respond to, negotiate with and change the strategic future of the organization."</i>

Resource: Compiled by author

According to SRI researchers, managers should understand their stakeholders' expectation and needs while planning the corporate objectives (Freeman, 2010). Following the definition of SRI, many other definitions have been proposed in the literature. In the year 1983, Freeman and Reed proposed two definitions (narrow and wide) for the stakeholder concept. These definitions revealed that stakeholders are crucial for organizations to survive, and there is a reciprocal relationship between organizations and their stakeholders. Among all these definitions, the most commonly accepted and cited definition belongs to Freeman. In his seminal book *Strategic Management: A Stakeholder Approach*, Freeman defined a stakeholder as “any group or individual who can affect or is affected by the achievement of the organization's objectives” (1984). This definition is one of the broadest definition in the literature, which implies that almost everyone can be a stakeholder. Later, Hill and Jones (1992) defined stakeholder. This definition implied that stakeholders provide resources, which are vital for firms, to survive in a competitive environment. Besides, this is the first definition that added legitimacy as one of the stakeholder characteristics (Miles, 2015).

Goodpaster (1991) used the metaphor of “player” in a poker game to define stakeholder. This identification was the first stakeholder definition that included risk element. However, Clarkson (1994) is known with the contribution to the stakeholder concept with risk. Jones (1995) definition was the first definition, which included the “power” attribute to the stakeholder concept.

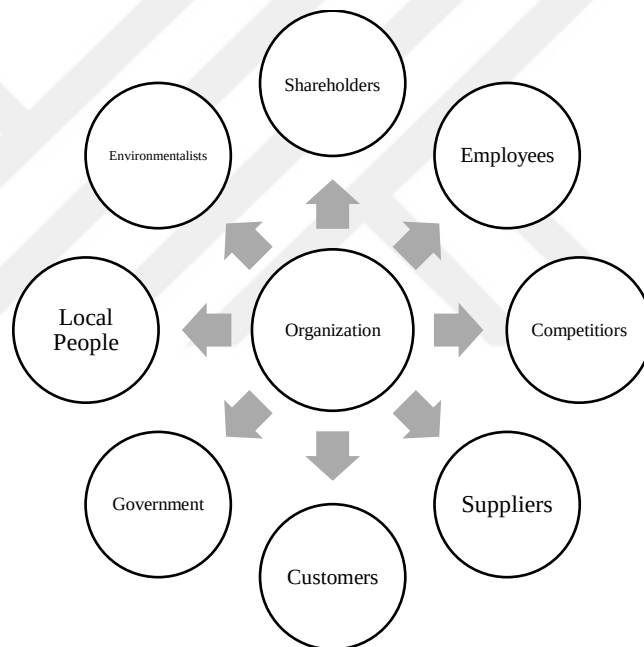
When the definitions in Table 5 are examined, the following inferences are made about stakeholders. First, stakeholders are crucially important for the existence of an organization. Second, stakeholders are influenced by the success of the business, or they affect the success of the business. Third, stakeholders have a relationship with the organizations and have a right to change based on the existence of the relationship of change.

From the traditional perspective, people or groups who provide necessary resources for production or who buy products or services are considered as stakeholders. However, as time passed and the size of the organizations increased, ownership and management were separated from each other. The number of groups that the organization needs to connect has been increased, and integration with these

groups become inevitable. These changes in the organization increased the number of stakeholders, meaning that owners and employees of the organizations were also considered as stakeholder groups. Managers have to understand these changes affected the business and to consider the relationship of the business with its stakeholders (Argandona, 1998; Mallin, 2004).

Today, with the increased number of stakeholders, the relationship between the stakeholder and the business has completely changed. Figure 7 shows the stakeholder-oriented perspective of the organizations and the main stakeholders owned by the organization.

Figure 7: Stakeholders of an Organization



Resource: Mallin, 2004

Now, stakeholders are capable of helping or harming the organization (Gibson, 2000). Shareholders, employees, suppliers, customers, financial institutions, local people, environmental groups, government all considered as stakeholders and need to be taken into account by the entity. Because of the organizations do not meet the stakeholders' expectations, stakeholders will not maintain their relationships. This requirement necessitates focusing on stakeholders (Lorca and Garcia-Diez, 2004). Thus, a stakeholder-oriented perspective has emerged in organizations.

3.1.1.2. Classification of Stakeholders

To have a stakeholder-oriented perspective, organizations need to classify their stakeholders and create relations based on these classifications. Identifying and classifying the stakeholders ease the management of them and enable them to observe how they affect the organization's performance (Raman, 2002). In the literature, different classifications have been made to identify the stakeholders considering the importance level. Table 6 the different classifications applied by several authors.

Table 6: Stakeholder Classification Typologies

Author(s)	Number of Classifications	Name of the Classifications
Evan and Freeman (1988)	2	Narrow and wide stakeholders
Lerner and Fryxell, 1988	5	Customer, community, stockholder, government and employees
Droge et al. (1990)	13	Shareholders, customers, voters, the general public, the financial community, lawmakers, communities, the press, higher education, employees and their families, labour unions, company distributors and other companies including competitors
Goldpastor, 1991	2	Strategic and moral stakeholders
Carroll, 1993	2	Primary and secondary stakeholders
Mahoney, 1994	2	Active and passive stakeholders
Morgan and Hunt, 1994	4	Internal, buyers, suppliers and lateral
Clarkson, 1995	2	The primary and the secondary stakeholders
Henriques and Sadorsky, 1999	4	Regulatory stakeholders, organizational stakeholders, community stakeholders, media
Sirgy, 2002	3	External, internal and distal stakeholders
Lorca and Garcia-Diez, 2004	2	Voluntary and involuntary stakeholders

Resource: Compiled by author

Mahoney (1994) divided the stakeholders into two groups, which are active and passive stakeholders. Active stakeholders are directly involved in the organization's activities. Nevertheless, it is not required that all of the active stakeholders are formally structured in the organization scheme (Mahoney, 1994). Passive stakeholders do not need to take part in the organization's policymaking. They are still powerful yet on purpose, but they are not keen to take part actively (Mahoney, 1994).

Henriques and Sadorsky (1999) divided the stakeholders into four groups, which are regulatory stakeholders, organizational stakeholders, community stakeholders and media. Governments, informal networks, and industry leader competitors consist of regulatory stakeholders (Kelley, 1991; Barrett, 1992; Allen, 1984). According to Henriques and Sadorsky (1999), regulatory stakeholders (except governments) have the capability of persuading governments to adopt similar environmental practice or technology. Organizational stakeholders affect the business from the shortest route and have the ability to influence the profitability of the business. Customers, suppliers, employees and shareholders constitute of organizational stakeholders. Local people, environmental groups and other potential lobbies consist of community stakeholders. These stakeholders have the power of altering the public opinion in countenance or against the organization's environmental performance (Turcotte, 1995). The last stakeholder group is the media, which includes mass communication groups (Henriques and Sadorsky, 1999).

Sirgy (2002) conducted another stakeholder classification. According to his classification, stakeholders can be divided into three dimensions: internal stakeholders, external stakeholders and distal stakeholders (Sirgy, 2002). Organizations trade vital resources with external stakeholders such as customers, distributors, suppliers, creditors, employees, local community. Continuity of an organization depends on the intensity of the exchange of values with external stakeholders (Sirgy, 2002). Organizations must be divided into business segments and organized accordingly, to achieve intense exchange. The division of organization implies the internal stakeholders of the organization, such as the board of directors, departments (Sirgy, 2002). The third stakeholder group is distal stakeholders who indirectly have an impact on the continuity and growth of the business. Distal stakeholders include higher

educations, industry leaders, environmental advocacy groups, trade associations, labour unions, lawmakers.

Lorca and Garcia-Diez (2004) divided the stakeholders into two dimensions: voluntary and involuntary stakeholders. Shareholders, employees, customers, and suppliers are consists of voluntary stakeholders who are directly involved with organizational activities and expected to receive benefits as a result (Lorca and Garcia-Diez, 2004). Involuntary stakeholders are affected by the negative consequences that the organization causes such as pollution or congestion, and end endeavour to diminish the negative consequences.

3.1.1.3. The roots of stakeholder identification and salience theory

The foundation of stakeholder identification and salience theory is based on the normative stakeholder theory and focuses explicitly on questions like “who are the stakeholders of the firms” and “whom should a manager pay attention?” (Mitchell et al., 1997). SIST provides an understanding of how the combination of power, legitimacy and urgency leads to form different stakeholder types with different behavioural patterns considering the organization (Mitchell et al., 1997). Thus, before providing details of SIST, the assumptions and critics of stakeholder theory is going to be discussed.

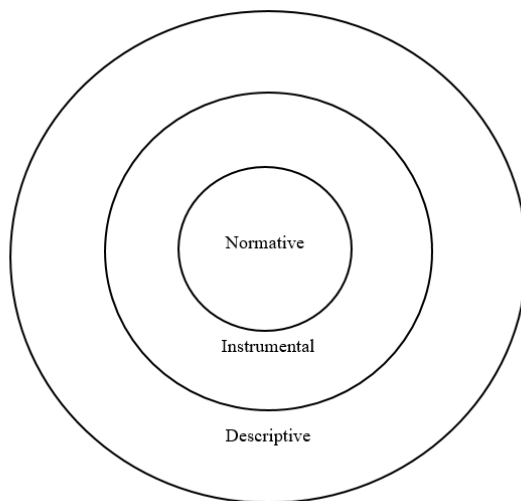
Stakeholder theory is concerned with the relationship between the organization and its stakeholders. The underlying assumption of stakeholder theory is the goal of an organization is to form and allocate value to stakeholders, and the mutual effort and support of stakeholders are the determinants of success of goal (Freeman, 1984). The three assumptions of the stakeholder theory are; i) organizations can be viewed as a set of interdependent relationships among primary stakeholders (Freeman, 1984; Hillman and Keim, 2001); ii) the goal of an organization is not to increase the wealth of the shareholders but the wealth of stakeholders (Freeman, 1984; Minoja, 2012); iii) increase the coordination and collaboration within stakeholders (Freeman, 1984; Minoja, 2012).

For managing stakeholders effectively, organizations should focus on three concepts, which are identifying the stakeholders and rights of stakeholders on the

organization, identifying the business relationship with its stakeholders and the processes necessary to manage these relationships and the execution of transactions between the organization and its stakeholders (Freeman, 1984). Stakeholder theory has been promoted with different arguments considering the user's motivation. Donaldson and Preston (1995) identified three different aspects of stakeholder theory, which are descriptive/empirical, instrumental and normative.

While three aspects support each other mutually, the normative aspect forms a basis of all the aspects that stakeholder theory has. Donaldson and Preston (1995) stated that the three aspects of the theory are intertwined. The first layer of the theory is its descriptive aspect, which helps to show and explain the observed relationships in the external world. Descriptive accuracy of the theory is supported by the second layer of the theory, which is an instrumental aspect. The core of the theory is a normative aspect (Donaldson and Preston, 1995). The relationship between the three aspects is shown in Figure 8.

Figure 8: Three Aspects of Stakeholder Theory



Resource: Donaldson and Preston, 1995

Descriptive aspect is defined as *“a model describing what the corporation is. It describes the corporation as a constellation of co-operative and competitive interests possessing intrinsic value”* (Donaldson and Preston, 1995). Stakeholder theory becomes descriptive when it is utilized to analyse the nature of the state of the

company, including stakeholders. So, stakeholder theory can be used to interpret the nature of the firm; manager's understandings about the management of the firm; the board members understandings about the corporate constituencies. The rationalization of the descriptive stakeholder theory tries to demonstrate that the explained concepts in theory and the observed realities correspond to each other.

Instrumental aspect deals with the reuniting the stakeholder management practices and achievement of corporate performance goals (Donaldson and Preston, 1995). The rationale behind this effort originates the suggestion that firms apply stakeholder management activities do better than the other firms in terms of the indicators such as profitability, stability and growth. This approach is considered as hypothetical because it offers such sentence: "if you want to achieve (avoid) results in X, Y, Z, then adopt (do not adopt) principles and practices A, B, C (Donaldson and Preston, 1995).

The normative aspect bases on the moral and philosophical principals while interpreting and guiding the firm's function. This aspect gives respond to stakeholder identity from a moral viewpoint. The normative aspect, which found the basis of the stakeholder theory, accepts that individuals besides the stakeholders have reasonable interests and these interests have real values. The normative aspect considers that each stakeholder has real value whether or not the individual or group has actual power or legal authorization (Donaldson and Preston, 1995). Many researchers claim that the normative aspect is the fundamental, instrumental and descriptive aspects form the basis of any stakeholder argument (Donaldson and Preston, 1995; Mitchell et al., 1997; Jones and Wicks, 1999).

However, the stakeholder theory is not flawless. There are some critics of stakeholder theory. The first critic is about determining the stakeholders. According to stakeholder theory, external stakeholders must be derived extraneously, meaning that independently chosen from board members and managers (Mitchell et al., 1997). However, neither identification of external stakeholders nor the legitimacy of the external stakeholders is clear (Ambler and Wilson, 1995). Another critic is about power. Stakeholder theory fails to explain how stakeholders can be represented or how they can maintain power to receive the interest that requires (Cummings and Patel, 2009). Determination of "stake" is another issue that leads to criticism of the

stakeholder theory. (Ambler and Wilson, 1995; Donaldson and Preston, 1995; Mitchell et al., 1997). In terms of money, “stake” can be determined easily for shareholders or employees. However, when the organizations also need to consider other human and social variables, it becomes difficult to determine “stake” (Mitchell et al., 1997). Mitchell, Agle and Wood develop a theory to overcome these critics.

Mitchell, Agle and Wood developed stakeholder identification and salience theory (SIST) in 1997. SIST is defined as “*the degree to which managers give priority to competing stakeholder claims*” (Mitchell et al., 1997). SIST tries to understand when a stakeholder get in contact with the organization (Neville et al., 2011). According to this theory, organization (manager) assign value to stakeholders and classify them based on their priority considering their salience (Beckman et al., 2016). A fundamental assumption of this theory is that organizations can be unaware of their stakeholders and interpret the contractual claims mistakenly, especially when organizations do not notice their stakeholders and their salience accurately (Wood et al., 2018).

In their article *Toward a Theory of Stakeholder Identification and Salience: Defining the Principles of Who and What Really Counts*, authors mentioned that although power and legitimacy are two critical aspects for stakeholders, they are treated as competing variables instead of intersecting variables (Mitchell et al., 1997). This situation is not only right for stakeholder theory, but also other theories (such as agency; resource dependence theory; transaction cost theory) accepts the two aspects (power and legitimacy) as competing variables. From these theories, we learn that power is a crucial aspect, yet, it is not enough to identify the salience of stakeholders. In real life, some of the stakeholders do not have the power, yet they are essential for the organizations.

Theories such as institution and population ecology theory imply that organizational legitimacy is vital for the survival of an organization (Meyer and Rowan, 1977; Carroll and Hannan, 1989). These organizational theories ascertain that legitimacy shows organizations to which stakeholders deserve managerial attention (Mitchell et al., 1997). Nevertheless, focusing the only legitimacy and ignoring power aspect leads to missing critical stakeholders since they might not have influence (Mitchell et al., 1997).

The last aspect of the stakeholder identification and salience theory is urgency, which is related to the degree to which stakeholder claims call for immediate attention (Mitchell et al., 1997). Although urgency aspect is not the fundamental basis of any theory, it has been used implicitly in many theories such as in agency theory, behavioural theory, institutional theory, resource dependence theory, and population ecology theory (Mitchell et al., 1997). Since urgency requires attention and need to respond fast, gives an accelerating element to the theory of stakeholder salience (Mitchell et al., 1997).

3.1.1.4. Stakeholder identification and salience theory

As it is briefly mentioned above, there are three main attributes of stakeholder identification and salience theory. In this section, more information is given for each attribute.

The first attribute is power. Although it is hard to define the power, in an organization or a supply chain, parties know who has the power (even instinctively). Weber defined power as *“the probability that one actor within a social relationship would be in a position to carry out his own will despite resistance”* (1947). The power of one party continues to exist as long as that party has access to coercive, utilitarian or normative means. Thus, power does not continue attribute, and it can be gained and lost within time (Mitchell et al., 1997). Etzioni (1964) classifies power into three types based on their occurrence way, coercive, utilitarian and normative. Fear and physical resources of force form the basis of coercive power. The coercive power is defined as *“the control based on the application of physical means”* Etzioni (1964). The foundation of utilitarian power is remuneration and extrinsic rewards (material or financial) to control other parties within the organization. *“The use of material means for control purposes”* is defined as utilitarian power (Etzioni, 1964). Normative power is based on symbolic and intrinsic rewards (such as prestige, esteem, and acceptance) and deprivations to control other parties. Normative power is defined as *“the use of symbols for control purpose”* (Etzioni, 1964).

The second attribute is legitimacy. Legitimacy is defined as *“a generalized perception or assumption that the actions of an entity are desirable, proper or*

appropriate within some socially constructed system of norms, values, beliefs and definitions” (Suchman, 1995). Some of the authors, who define stakeholder theory narrowly, focus on building stakeholder theory based on legitimacy. These authors implicitly make assumptions about how legitimate stakeholders also hold power in an organization while sometimes this is not the actual case. Thus, legitimacy is implicitly combined with power, although both of the concepts are distinct attributes (Weber, 1947). Legitimacy has multiple levels of analysis which are individual, organizational and societal (Wood, 1991).

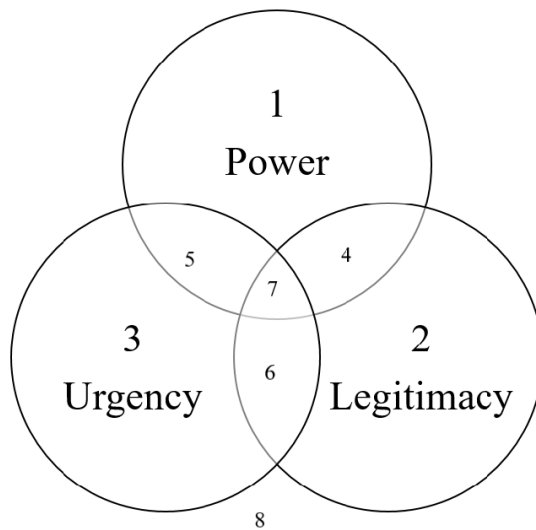
The last attribute is urgency. Urgency is defined as *“the quality of being very important and needing attention immediately”* (Cambridge Dictionary, 2020). The urgency has two characteristics, time sensitivity and criticality (Mitchell et al., 1997). Time sensitivity is related to the point at which stakeholder cannot accept a delay in the participation of a claim or relationship. In contrast, criticality is related to the priority of claim/relationship to the stakeholder (Mitchell et al., 1997). Based on these characteristics, Mitchell et al. (1997) defined urgency as *“the degree to which stakeholder claims call for immediate attention”*.

Besides these three attributes, Mitchell et al. (1997) identified several additional attributes to ensure the dynamism of the theory. These additional attributes are:

- i. Stakeholder attributes are variable (not steady-state).
- ii. Stakeholder attributes are socially constructed, not objective, reality.
- iii. Consciousness and willful exercise may or may not be present.

Although a different type of classification has been conducted in the literature, in this study, Mitchell’s qualitative stakeholder classification is adapted and used. Mitchell et al. (1997) developed a different classification for identification of stakeholder groups based on the theory’s attributes. Figure 9 shows the qualitative classes of stakeholders.

Figure 9: Qualitative Classes of Stakeholders



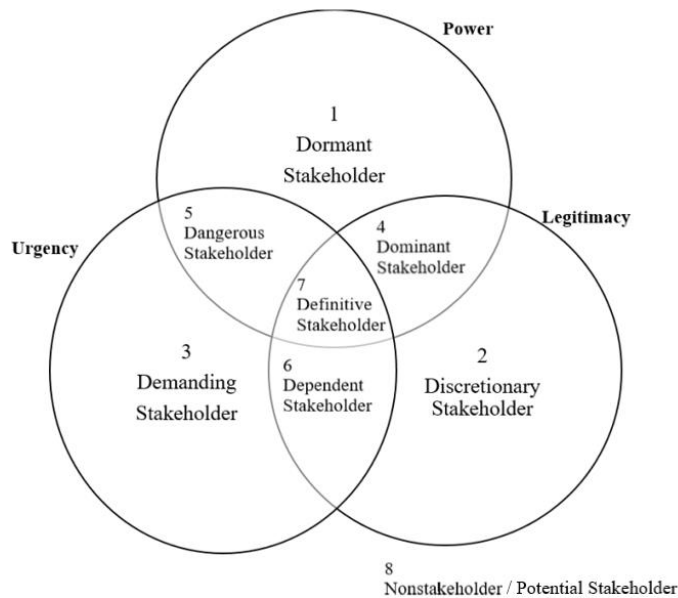
Resource: Mitchell et al., 1997

Based on this classification, there are seven types of stakeholders. Three of them has one attribute, while another three of them has two attributes and one type of stakeholder has all attributes. According to Mitchell et al. (1997), stakeholders can be identified based on having these attributes with further methodological and empirical work (stakeholder mapping). Moreover, utilizing such method and analysing stakeholders enable to identify the salient stakeholders. Besides, this model proposes that an organization which does not have power, urgency and legitimacy factors are not considered as stakeholders (Mitchell et al., 1997).

The central proposition of this theory is “stakeholder salience will be positively related to the cumulative number of stakeholder attributes – power, legitimacy and urgency- perceived by managers to be present (Mitchell et al., 1997). Stakeholders, who have one attribute, are considered as the low salience or “latent” stakeholders. Stakeholders, who have two attributes, are considered as the moderately salient stakeholders or “expectant” stakeholders. Stakeholders, who have three attributes, are considered as highly salient stakeholders (Mitchell et al., 1997). Mitchell et al. (1997) entitled latent stakeholders as a dormant stakeholder, discretionary stakeholder and demanding stakeholder; while they named expectant stakeholders as a dominant stakeholder, dangerous stakeholder and dependent stakeholder. Also, Mitchell et al. (1997) named highly salient stakeholders as definitive stakeholders. Lastly, if a

stakeholder does not any of the attributes, they are considered as non-stakeholders or potential stakeholders. Figure 10 shows the stakeholder typology.

Figure 10: Stakeholder Typology: One, Two or Three Attributes Present



Resource: Mitchell et al. (1997)

Since all organizations have limited resources (time, money, energy) and capabilities to pursue each stakeholder group, managers are reluctant to take any action for stakeholders who has one attributes. Similar to managers' approaches; latent stakeholders do not keen to give attention or recognition of the organization (Mitchell et al., 1997). Dormant stakeholders, discretionary stakeholders and demanding stakeholders are three types of latent stakeholders.

Power is the related attribute of dormant stakeholders (Mitchell et al., 1997). Dormant stakeholders have the power to dictate their claims, yet since there is no legitimate relationship or an urgent claim, they do not use their power (Mitchell et al., 1997). Dormant stakeholders' interactions are limited to the firm.

Legitimacy is the main attribute of discretionary stakeholders, and they cannot affect the organizations due to lack of power and no urgency claims (Mitchell et al., 1997). When the "urgency" is the only attribution of a stakeholder group, they are identified as demanding stakeholders. Demanding stakeholders have urgent claims, yet they do not have either power or legitimacy to force organizations to take action.

Their efforts are mainly considered as “noise” by the organization and organization keep ignore demanding stakeholders until they obtain a second attribution (Mitchell et al., 1997). Organizations should keep in mind that a second attribution possession is possible due to the dynamic nature of stakeholders. Thus, organizations must be aware of latent stakeholders.

The level of salience has changed when the stakeholders have two out of three attributes (Mitchell et al., 1997). While stakeholders, who have one attribute, have latent relationships with the organizations, stakeholders, who have two attributes, are considered as having expectations from organizations. In addition, latent stakeholders are positioned as passive actors, while expectant stakeholders are considered as active (Mitchell et al., 1997). Thus, the stakeholder-organization engagement level is higher for expectant stakeholders. Dominant stakeholders, dangerous stakeholders and dependent stakeholders are the main types of expectant stakeholders.

When a stakeholder group has both power and legitimacy attributes, they are considered as a dominant stakeholder because their impact on the organization is guaranteed (Mitchell et al., 1997). This group is named as dominant because they have rights on the organization and force to claim them. Organizations give priority and importance to their dominant stakeholders’ expectations (Mitchell et al., 1997). Nevertheless, it is also possible that due to the dynamic nature of the relationships, dominant stakeholders can gain urgency attribute and become definitive stakeholders. Employees, the board of directors, the government are considered as dominant stakeholders.

When a stakeholder group has a legitimate urgent claim on organization, they are called dependent stakeholders. However, since dependent stakeholders do not have the power to indulge their willing, they rely on others (Mitchell et al., 1997), especially who owns the power. Nevertheless, it is also possible that due to the dynamic nature of the relationships, dependent stakeholders can gain power attribute and become definitive stakeholders (Mitchell et al., 1997).

Dangerous stakeholders are considered as stakeholders who have urgency, and power attributes yet do not have legitimacy. Because of this situation, this type of stakeholders can be coercive, and there is a chance for being violent (Mitchell et al.,

1997). For organizations, it is essential to identify these type of stakeholders because only after the identification, mitigation of danger or preparation can be possible.

As it is already mentioned above, when a stakeholder group has three attributes at the same time, they are considered as definitive stakeholders (Mitchell et al., 1997). Each moderate-salience stakeholder can turn into definitive stakeholder with attaining remaining attribute under the right circumstances (Mitchell et al., 1997).

3.1.1.5. Utilization of stakeholder identification and salience theory in logistics and supply chain management

When the literature is examined, stakeholder identification and salience theory have been used widely in logistics and supply chain management. SIST has been utilized in supply chain management to identify stakeholders. Co and Barro (2009) employed SIST to establish a framework, identify the stakeholders and develop management strategies to reach supply chain collaboration. Tai et al. (2014) used SIST to understand whether stakeholders' salience affects the suppliers' IT infrastructure integration.

However, recently, the usage of theory has been moved forward to other areas such as waste management and agri-food supply chain. Suherman et al. (2018) used stakeholder identification and salience theory to provide understanding about authority and responsibility that should be taken by specific stakeholders in the household solid waste management.

Application of SIST to food supply chains are quite recent and to the best of authors' knowledge, such studies only conducted for Greek and Spanish agri-food supply chains. Tsoulfas et al. (2019) employed SIST to define the role of stakeholders in sustainable agri-food supply chains in Greece. For the Greek agri-food supply chain, the theory was used to identify the salient stakeholder groups who are essential for achieving sustainability (Tsoulfas et al. 2019). Pedrosa-Ortega et al. (2019) used three attributes of the stakeholder identification and salience model. Moreover, another attribute (durability) was added to the model. Results revealed that the order of the attributes changes according to the type of company in Spanish agri-food supply chains.

However, no studies have been employed stakeholder salience and identification theory to identify which stakeholders have more salience while tackling with the food loss on the food supply chains. Thus, this thesis utilize SIST to identify salient stakeholders, who will have an influence, while tackling food loss.

3.1.2. Theory of Critical Success Factors

Theory of critical success factors (TCSFs) has been used widely in a different context such as business, marketing and supply chain management (Tu et al., 2018; Aschemann-Witzel et al., 2017; Lin, 2015; de Sousa, 2004). Critical success factors (CSFs) are also known as “key factors”, “success factors” or “critical factors” (Marais et al., 2017). Theory of CSFs suggests that in the case of achieving satisfactory results in certain areas which are chosen as success factors will enable competitive advantage to organizations (Shankar et al., 2018).

The theory implies that several critical concepts affect the success and efficiency of an organization while enabling a firm to reach its goals. Identifying CSFs is not related to gathering information for strategic planning. Instead, CSFs focus on the organization’s needs to identify, manage, and control the data, which can be used for monitoring and improving existing business areas. The core of the CSF theory implies that firms should focus on their resources and factors that provide them with a competitive advantage (Rockart, 1979; Ferguson and Dickinson, 1982; Leidecker and Bruno, 1984). CSFs are not the firm’s objective or goal, but they are enablers for a firm to achieve its objectives or goals (Brotherton and Shaw, 1996). CSFs can be specified from not only the firm’s internal and external environments but also a wide variety of cases, situations, events that firm needs to focus specifically (Dickinson et al., 1984). However, CSFs are not compared with performance indicators (Freund, 1988). In the next section, the notion behind the theory of CSFs is going to be justified.

3.1.2.1. The concept of critical success factors

The concept of critical success factors first appeared in Ronald Daniel’s article named “*Management information crisis*” in 1961. In this article, he identified that organizations need to choose “success factors” considering their management

approach as well (Daniel, 1961). The article focused on industry-related success factors related to any company in a specific industry. Although the concept of CSFs appeared in 1961, John Rockart made the commonly accepted definition of CSFs in 1979. Notwithstanding, Rockart's definition is not the only definition in the literature. Table 7 shows commonly used definitions while justifying the critical success factors concept.

Table 7: Definitions of CSFs

Authors	Definition
Hofer and Schendel (1978)	<i>"variables which management can influence through its decisions that can affect significantly the overall competitive positions of the various firms in an industry."</i>
Rockart (1979)	<i>"for any business, the limited number of areas in which results, if they are satisfactory, will insure successful competitive performance for the organization. They are the few key areas where 'things must go right' for the business to flourish."</i>
Leidecker and Bruno (1984)	<i>"those characteristics, conditions, or variables that when properly sustained, maintained or managed can have a significant impact on the success of a firm competing in a particular industry."</i>
Pinto and Slevin (1987)	<i>"factors which, if addressed, significantly improve project implementation changes."</i>
Digman (1990)	<i>"the areas where things must go right for the business to flourish."</i>
Guimaraes et al. (1999)	<i>"the critical areas that management must constantly monitor to ensure successful performance by the organization."</i>
Milosevic and Patanakul (2005)	<i>"characteristics, conditions or variables that can have a significant impact on the success of the project when properly sustained, maintained or managed."</i>

Resource: Compiled by author

Hofer and Schendel's definition implies that CSFs are apparent and easy to determine via using sensitivity and elasticity analysis. However, contradictory views

imply that CSFs are not that obvious as Hofer and Schendel were implied. When the Leidecker and Bruno (1984)'s definition and Pinto and Slevin (1987)'s definition are examined, we can deduce that both definitions miss the extensive link which tries to balance between environmental conditions and business characteristics of a firm that Rockart's definition proposes. Although there are different definitions occur in the literature, no consensus has been achieved for a clear definition of critical factors (Aschemann-Witzel et al., 2017).

The industry, competitive strategy and industry position, environmental factors, temporal factors and managerial position are classified as primary sources of CSFs (Bullen and Rockart, 1981; Leidecker and Bruno, 1984). According to this viewpoint, each industry will have its own unique CSFs based on their nature, and firms in that industry take into consideration of industry-specific CSFs (Leidecker and Bruno, 1984). Moreover, firms need to pay attention to CSFs, which are related to their business area and position. Based on the firm's position in the industry, CSFs vary. For example, while a small firm has CSFs, which helps to understand the industry-dominating firm, the industry-dominating firm will have CSFs, which enable them to maintain their position (Bullen and Rockart, 1981). Firms should check the economic and socio-political environment regularly to identify CSFs that will be the indicator of success (Leidecker and Bruno, 1984). When unordinary things happen in the industry, temporal factors gain importance (Bullen and Rockart, 1981). Each functional unit has its CSFs considering their tasks (Bullen and Rockart, 1981).

3.1.2.2. The roots of critical success factors theory

After World War II, organizations had entered a new era. Organizations have begun to grow rapidly to meet the high demand. To satisfy the excessive demand, organizations had changed their business models. However, they could not be able to improve their management systems and decision-making mechanisms at the same speed. Most of these organizations reacted this situation with coming up new reporting systems. In the early 1960s, a McKinsey and Company consultant - named Ronald Daniel- published an article in Harvard Business Review named as "*Management information crisis*". In this article, Daniel (1961) proposed a concept, which is

currently known as “Critical Success Factors”. In his article, he proposed that organizations need to choose “success factors” since they were having problems while choosing the utmost attention requiring factors, which needed for decision-making (Daniel, 1961). Besides, it is mentioned that this choosing problem occurs because of the very quickly changing businesses. To be successful, each firm needs to identify its own success factor, which is also valid for each department within the firm (Daniel, 1961). This viewpoint implies the uniqueness and individuality of the success factors. Nonetheless, throughout the years, different perceptions have occurred in terms of individuality and uniqueness. The concept of success factors had started to gain attention in 1972 after Anthony et al. (1972) employed the concept during the design of a management control system. Anthony and Dearden (1976) mentioned that crucial variables, which affect profitability, were determined by the management control systems.

The breakthrough of critical success factors occurred in 1979 with the Rockart’s article, which was named as “*Chief executives define their own data needs*”. In this article, Rockart (1979) introduced a new approach to help managers, specifically top management, to determine relevant information needs to manage firms effectively. He used the ideas of Daniel (1961) and Anthony et al. (1972) to shape the concept of critical success factors. In the same article, Rockart researched three firms and confirmed that firms within the same industry could have different CSFs, and it was stated that CSFs is a top-down methodology. In parallel to the first study, Rockart (1982) conducted another study in the information system to show that executives share a limited number of CSFs. Tregoe and Zimmerman (1980) researched CSFs and stated that CSFs could be used to strategy formulation. Leidecker and Bruno (1984) published an article, which helped to improve the theory of CSFs. In their article, they suggested that chosen CSFs affect the firm’s progress in distinct industries (Leidecker and Bruno, 1984). Until 1984, theory solely used for large corporations but Dickinson et al. (1984) employed CSFs on the small business. Jenster (1987) developed nine steps to identify CSFs. Freund (1988), Grunert and Ellegaard (1993), Flynn and Arce (1997), Caralli (2004) have conducted similar attempts to identify and select CSFs.

3.1.2.3. Classification (Dimensions) of Critical Success Factors

Understanding the classifications of CSFs is a valuable contribution during the achievement of the firm's objectives. According to literature, six types of classification occurs for CSFs. They are individual vs organizational, temporal vs ongoing, internal (endogenous) vs external (exogenous), building/adopting vs monitoring, strategic vs tactical, and perceived vs actual (Rockart, 1979; Bullen and Rockart, 1981; Ward, 1990; Eberhagen and Naseroladl (1992); Grunert and Ellegard, 1993; Flynn and Arce, 1997; Kelly et al., 1999; Khandewal and Ferguson, 1999). In this section, each of the classifications is explained.

While CSFs are used as a tool on the way of achieving the firm's objectives, each department/unit can have a different set of CSFs (Bullen and Rockart, 1981). These are named as individual CSFs (Khandewal and Ferguson, 1999). Rockart (1982) mentioned that CSFs could be combined. While each department has its own individual CSFs, the firm will have its own aggregated (organizational) CSFs (Khandewal and Ferguson, 1999).

According to Khandewal and Ferguson (1999), in terms of duration, CSFs can be temporal or ongoing. Dynamism is a crucial concept of business, and all businesses face with dynamism with certain levels. Because of the dynamism, firms' priorities can change over time. Once certain CSFs are achieved/completed, they might be no longer required to control. In these circumstances, these type of CSFs is considered as temporary. Nevertheless, some type of CSFs needs to be continuously monitored with some updates. These type of CSFs are considered as ongoing. Moreover, Khandewal and Ferguson (1999) mentioned that at first, CSFs are determined as temporal, but when they gain importance or become a routine of a task, they evolve to ongoing CSFs.

While internal CSFs are factors related to the operations inside of the firm, external CSFs are related to the factors that are outside of the organization. Controlling the internal CSFs are under the initiative of the firm; while it is not possible to control the external CSFs (Bullen and Rockart, 1981). Factors that deal with an organization's current position are named as monitoring CSFs (Eberhagen and Naseroladl, 1992). Factors that are related to organizational change or future planning are called as building/adopting CSFs (Eberhagen and Naseroladl, 1992). Bullen and Rockart (1981)

mentioned that monitoring CSFs preferred to observe long-term factors while building/adopting CSFs are preferred when a change needs to be implemented. Strategic and tactical CSFs are related to planning. Strategic CSFs are related to reaching goals, while tactical CSFs shows the method for reaching the goal and timing (Ward, 1990). Strategic factors require long term planning; while tactical factors are shorter or medium-term planning. Chosen CSFs can vary between firms based on each firm's specific needs and requirements. The concept of perceived and actual CSFs gained importance, which was proposed by Grunert and Ellegard (1993). The difference between perceived and actual CSFs cause inconsistency, and this inconsistency is a valuable source and can be used by firms for strategy formulation and implementations (Grunert and Ellegard, 1993). Dess and Robinson (1984) proposed that organizations face with actual CSFs more often, although it is not possible to measure them. However, during this process, organizations can realize truly relevant factors and factors, which are only perceived as such.

3.1.2.4. Utilization of critical success factors theory in logistics and supply chain management

Theory of critical success factors is widely utilized in logistics and supply chain management (SCM) (Orji et al., 2020). These studies focus on the sustainability element while using the theory. Chowdhury et al. (2020) adapted the CSF theory to demonstrated vital success factors to achieve best management practices in the apparel supply chain of Bangladesh. In their study, Omain et al. (2019) adjusted CSFs theory to find critical factors that affect the implementation of green SCM practices in the automotive industry in Malaysia. Talib et al. (2015) used CSFs theory to identify success factors in the SCM context. Luthra et al. (2015a) employed the theory of CSFs to define and examine the CSFs to apply green supply chain management towards sustainability in India. Luthra et al. (2015b) made use of CSFs theory to describe and evaluate the factors of successful accomplishment of environmental sustainability in the Indian automobile industry.

Moreover, the theory of CSFs used for food supply chains. Shankar et al. (2018) employed critical success factors theory to determine the factors of successful

traceability systems for food logistics and formed a framework using the determining factors. Tu et al. (2018) used the theory of CSFs to explicate success factors of marketing ugly fruits and vegetables to biased consumers. Aschemann-Witzel et al. (2017) used the theory of CSFs to demonstrate successful factors, which help to reduce food waste amount and design future actions. Grimm et al. (2014) used the theory of CSFs to analyse and enhance the knowledge of success factors, which can be used to reduce challenges of sub-supplier management in the context of the food industry.

Recently, the theory of CSFs has been utilized in food waste management literature. (Garrone et al., 2016; Xu et al., 2016). Besides, the theory of CSFs is adopted in food waste management studies as well. Garrone et al. (2016) identified critical factors to eliminate food surplus in the food manufacturing companies. Xu et al. (2016) used theory to elucidate the factors of the successful food recycling program in a residential community in Shanghai. However, to the best knowledge of authors, no study has utilized theory to identify logistics factors, which lead to food loss in the supply chain. Thus, this study aims to elucidate the key logistics factors, which lead to food loss in the supply chain by employing the theory of critical success factors.

CHAPTER IV

METHODOLOGY

4.1. IDENTIFICATION AND CLASSIFICATION OF CRITICAL UPSTREAM AND MIDSTREAM SUPPLY CHAIN STAKEHOLDERS

4.1.1. Different Approaches in Stakeholder Analysis

Stakeholder analysis can be considered as *“an approach, a tool or set of tools to create knowledge about the actors (individuals and organizations)”* (Varvasovszky and Brugha, 2000). The primary purpose of stakeholder analysis is to determine actors to evaluate organization policies related to them and understand the stakeholders’ relevancy, intention and behaviours. Thus, collected information can be used both as a pathway for organizations to develop their policies and give insights into organizations about how they can improve their policies (Wang et al., 2012).

The purpose of stakeholder analysis has changed over time as a result of increased expectations of the organizations and differentiation of utilization area. Purpose, focus, interest, scope, time-frame and stage are the essential aspects that have changed. Figure 11 shows the evolution of the stakeholder analysis in due course. The stakeholder analysis was used to analyse the policies in the past. On the contrary, it is now used for the implementation of policies. Besides, in the future, stakeholder analysis is expected to be used while developing the policies (Varvasovszky and Brugha, 2000). In the past, the focus of the analysis was aiming to conduct retrospective analysis; while in today and future, the focus of the analysis is and will be prospective (Varvasovszky and Brugha, 2000). In the past, the interest of stakeholder analysis was processed; while today, the interest is the objectives that policies want to reach. In future, the interest is expected to be the aim of policies, which are formed as a result of the combination of objective (Varvasovszky and Brugha, 2000).

Figure 11: The Evolution of the Stakeholder Analysis in Due Course

Time Frame	Past	Now	Future
Dimension			
Purpose	Policy analysis	Policy implementation	Policy development
Focus	Retrospective	← ————— →	Prospective
Interest	Process	Objective	Goal
Scope	Broad	Narrow	Broad
Time frame	Long-term	Short-term	Medium-term
Stage	Historical analysis (Post-implementation)	Pre-implementation (Post-implementation)	Planning & Development

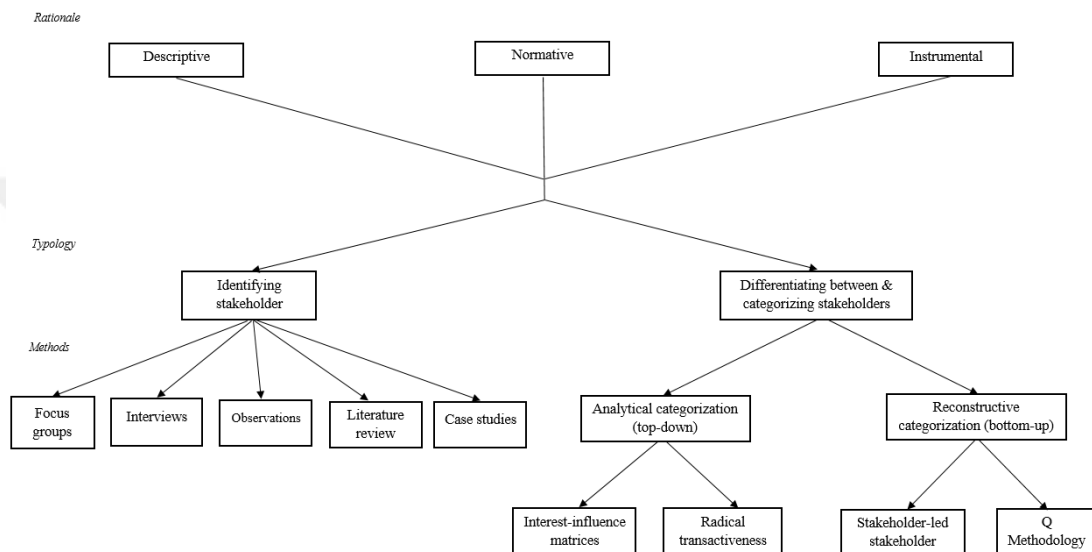
Source: Varvasovszky and Brugha, 2000

Varvasovszky and Brugha (2000) stated that the scope of the stakeholder analysis was broad in the past, yet today the scope of the analysis became narrower. Moreover, it is expected that in the future, it will become broad again. Hence, the time frame of the stakeholder analysis was long-term in the past; while now it is short-term. However, the time frame is expected to be medium-term for the future. The focus of stakeholder analysis was retrospective in the past. Therefore, the stages of the stakeholder analysis were also considered as historical analysis, and an evaluation was conducted after policy implementation. Today, stakeholder analysis can be conducted in both stages, meaning that before and after the policy implementation. Since in the future, stakeholder analysis is expected to use to develop policies, stakeholder analysis will be conducted at the planning and development stage as well (Varvasovszky and Brugha, 2000).

As the area of usage of stakeholder analysis was increased, the methods for stakeholder analysis has also changed. The stakeholder analysis methods are diversified considering three primary purposes which are descriptive, normative and instrumental (Reed et al., 2009). Descriptive stakeholder analysis is mainly conducted for preliminary purposes for preparing a substructure to conduct normative or instrumental stakeholder analysis. Descriptive stakeholder analysis identifies the stakeholders and their role in organizations (Reed et al., 2009). Results of normative stakeholder analysis are used as preliminary results while conducting the instrumental analysis. Normative stakeholder analysis aims to demonstrate which stakeholders are responsible for which tasks (Reed et al., 2009). The main activities conducted at

instrumental stakeholder analysis are the identification of stakeholders, determination of the tasks for each stakeholder and specifying methods to manage stakeholders' behaviours/expectations. Identification of management methods helps organizations to reach their aim (Reed et al., 2009). Figure 12 shows the methods used for stakeholder analysis.

Figure 12: Methods Used for Stakeholder Analysis



Source: adapted from Reed et al., 2009 and Khurram et al., 2019

Focus groups, interviews, observations, literature review, and case studies are commonly preferred methods for identifying stakeholders (Reed et al., 2009; Khurram et al., 2019). However, there is no unity in the utilization of these methods. Some researches prefer to use one method; while others prefer to combine more than one method. For example, David et al. (2007) used secondary data analysis to while determining the stakeholders to investigate the shareholder proposal activism, managerial response and corporate social performance. Magness (2008) identified stakeholder groups in mining industry via literature review to reveal stakeholder salience. Matilainen and Lahdesmaki (2014) used interviews to identify stakeholder groups while having the purpose of a developing high-quality nature tourism sector in rural areas with gathering viewpoints of the stakeholders. Driscoll and Crombie (2001) combined interviews and observations to identify stakeholder groups in a large pulp

and paper company with a small monastery and nature retreat centre. Winn and Keller (2001) employed interviews and literature review to identify stakeholder groups in the food supply chain. Parent and Deephouse (2007) combined case study, interviews and secondary data analysis to reveal stakeholder salience in sporting event organizations. Heidrich et al. (2009) combined interviews and observations to identify stakeholder groups in a business recycling company. Lu et al. (2014) employed interviews and records to classify stakeholders in the Chinese electric vehicle industry.

After the identification of stakeholders, the next step is differentiating and categorizing stakeholders. Researchers have employed two approaches, which are top-down “analytical categorizations” and bottom-up “reconstructive categorization” for this purpose (Dryzek and Barejikian, 1993). Analytical consideration underpins the arguments with relevant theories while classifying stakeholders based on observing the events (Hare and Pahl-Wostl, 2002). Urgency, legitimacy and influence (Mitchell et al., 1997) are one of the analytical categorizations (Reed et al., 2009). These kinds of analysis use matrices or Venn diagrams and commonly conducted for policy development purposes (Bianchi and Kossoudji, 2001; Bryson et al., 2002; Reed et al., 2009). Interest-influence matrices and radical transactiveness are two methods used for analytical categorization. Maguire et al. (2012) employed interest-influence matrix to identify stakeholders who need to be in the marine planning process. Wang et al. (2013) used interest- influence matrix to achieve efficient stakeholder management in drinking water supply systems in Shenzhen, China. Zhou et al. (2014) utilized interest-influence matrix as a tool for stakeholder analysis to determine and understand the relationship in the natural reserve areas in China. Tsoulfas et al. (2019) employed Venn diagram as a tool for conducting stakeholder analysis to identify which stakeholders are more salient while achieving sustainable agri-food supply chains.

While in interest-influence matrices, primary and secondary data can be the main source of analysis, two-way communication forms the foundation of radical transactiveness (Reed et al., 2009). Radical transactiveness was developed by Hart and Sharma (2004). Hart and Sharma (2004) specifically focused on the stakeholders who are off the beaten track, named these type of stakeholders as “fringe stakeholders”. Fringe stakeholders are considered as non-legitimate, weak, remote, yet they can be disruptive. Hart and Sharma (2004) argued that knowing and categorizing fringe

stakeholders is an essential task because firms can take precautions against problems that may occur due to this type of stakeholder group. This categorization approach has been widely applied in different contexts. For example, Murphy and Arenas (2010) identified fringe stakeholders and examined their impact on cross-sector collaborations. Khazaei et al. (2015) defined immigrants as fringe stakeholders and examined their participation and impact in tourism planning. McCarthy and Muthuri (2018) categorized women, non-literate and indigenous people as fringe stakeholders and investigated how the “fringe stakeholders” can be included stakeholder analysis via visual participatory research to get more inclusive and credible decision making.

Reconstructive categorization enables stakeholder classification with direct participation (Dryzek and Berejikian, 1993; Hare and Pahl-Wostl, 2002). Stakeholder-led stakeholders and Q methodology are the two methods of reconstructive categorization. Both methods employ empirical analysis based on stakeholder viewpoints (Reed et al., 2009). Hare and Pahl-Wostl (2002) used a card-sorting method to classify stakeholders. The card-sorting method has its origins in experimental psychology (Reed et al., 2009). In this method, each stakeholder was asked to sort cards which include all type of stakeholders. This method enables researchers to have the stakeholder viewpoint, and with this viewpoint, researchers define the group structures and interplay between stakeholders (Reed et al., 2009). Jones et al. (2009) employed the card-sorting method to identify stakeholder groups in a variety of industries.

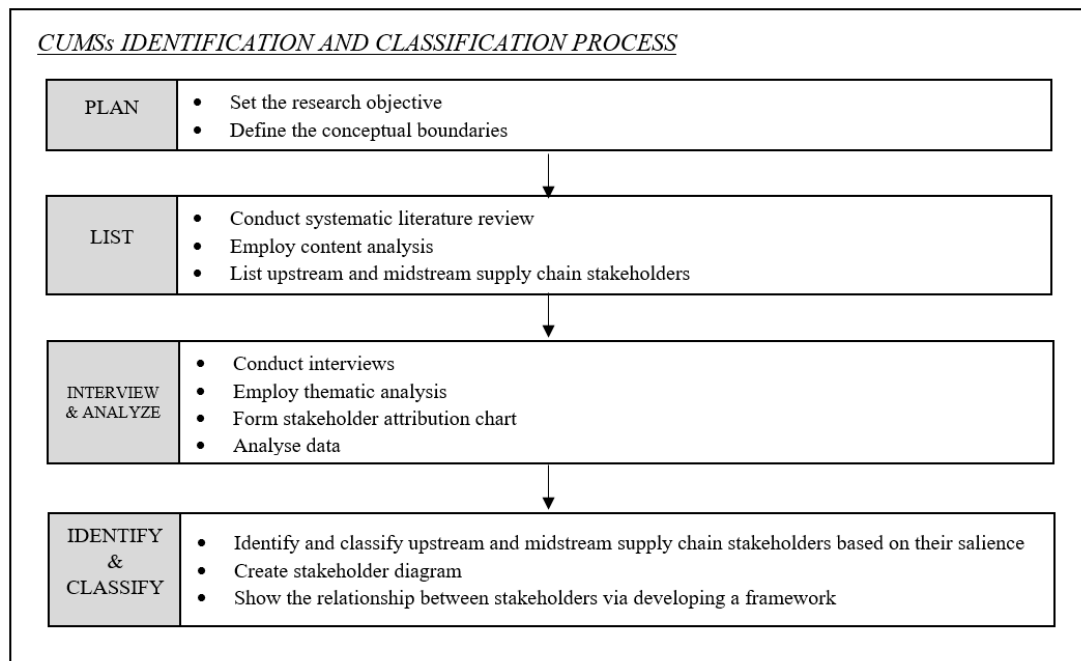
Q methodology is the other method used for reconstructive categorization. Similar to the card-sorting method, this method's origin is also psychology yet commonly preferred in political science by combining discourse analysis. Discourse analysis reveals people's viewpoints in certain subjects and shared senses. Following discourse analysis, Q method is applied to sort individuals into groups according to their shared opinions (Barry and Proops, 1999). Ockwell (2008) utilized Q method to identify stakeholders whose viewpoints later shaped fire planning of Cape York. Alam and Lovett (2019) aimed to get each stakeholders' viewpoints while planning and managing the green areas of Lahore. Thus, to identify each stakeholder group, they employed Q Methodology.

Both card sorting and Q methodology require large samples to conduct analysis. In such a large sample, it is hard to manage each stakeholder relationship. Besides, there is a chance that not every stakeholder can meaningfully be represented. Thus, the need for creating main groups, who have legitimacy, becomes inevitable. Thus, this type of analysis requires research flexibility. Also, in both methods, stakeholders tend to create their stakeholder group and tend to give a response to according to their concerns. This situation can end up with gliding on the focus of research.

4.1.2. Design of the Stakeholder Analysis

Considering the methods explained above, in this thesis to identify food supply chain stakeholders, a combination of literature review and interviews were employed. Moreover, while classifying food supply chain stakeholders according to their salience, a Venn diagram was utilized. Lastly, frameworks were developed to show the relationship between identified stakeholder groups. Figure 13 shows the stage of stakeholder analysis.

Figure 13: Design of Stakeholder Analysis



Resource: Compiled by author

In this thesis, four stages were employed to conduct the stakeholder analysis. The steps are to plan, list, interview, and analyse, and identify. Moreover, each stage has its steps. The first step of the stakeholder analysis was the planning stage. In this stage, the research objective(s) were set, and conceptual boundaries were identified. The objective of the stakeholder analysis is to identify which stakeholders have more salience while tackling the food loss on the food supply chains. Different journals were investigated, and a number of interviews were completed to achieve this purpose.

The second stage of the stakeholder analysis was the listing stage which includes conducting the systematic literature review, employing content analysis and listing the stakeholders.

The third stage of the stakeholder analysis was interviewing and analyzing stage. This stage has four steps. The first step of the analyzing stage is conducting interviews. To verify the listed stakeholders, it has been decided to ask the list to industry experts. Thus, I have created an interview outline and asked them to industry experts.

The interview questions can be found in the appendices (Appendix 1). As the second step, the interview results were examined via thematic analysis. With using the thematic analysis results, a stakeholder attribution chart was prepared for the evaluation of stakeholders. This chart included both three attributions of the stakeholder salience and identification model and the name of the identified stakeholder groups which were determined by content analysis and thematic analysis. For each food supply chain, a different stakeholder attribution chart is prepared. Template of the stakeholder attribution chart can be found in the appendices (Appendix 2). The last step is analysing the data which was retrieved from stakeholder attribution charts.

The final stage of the stakeholder analysis is the identify stage. At this stage, stakeholders who have more salience while tackling the food loss on the food supply chains are identified. Based on the analysis results, a Venn diagram is generated. Moreover, based on the identified stakeholders, a generic food supply chain framework was designed.

4.1.3. Data Collection, Sampling and Data Analysis

For stakeholder analysis, data collected via two methods, which are literature review and interviews. Utilizing literature review has enabled us to identify and list all possible stakeholders. In this section, the research process of literature review and interviews are going to be explained.

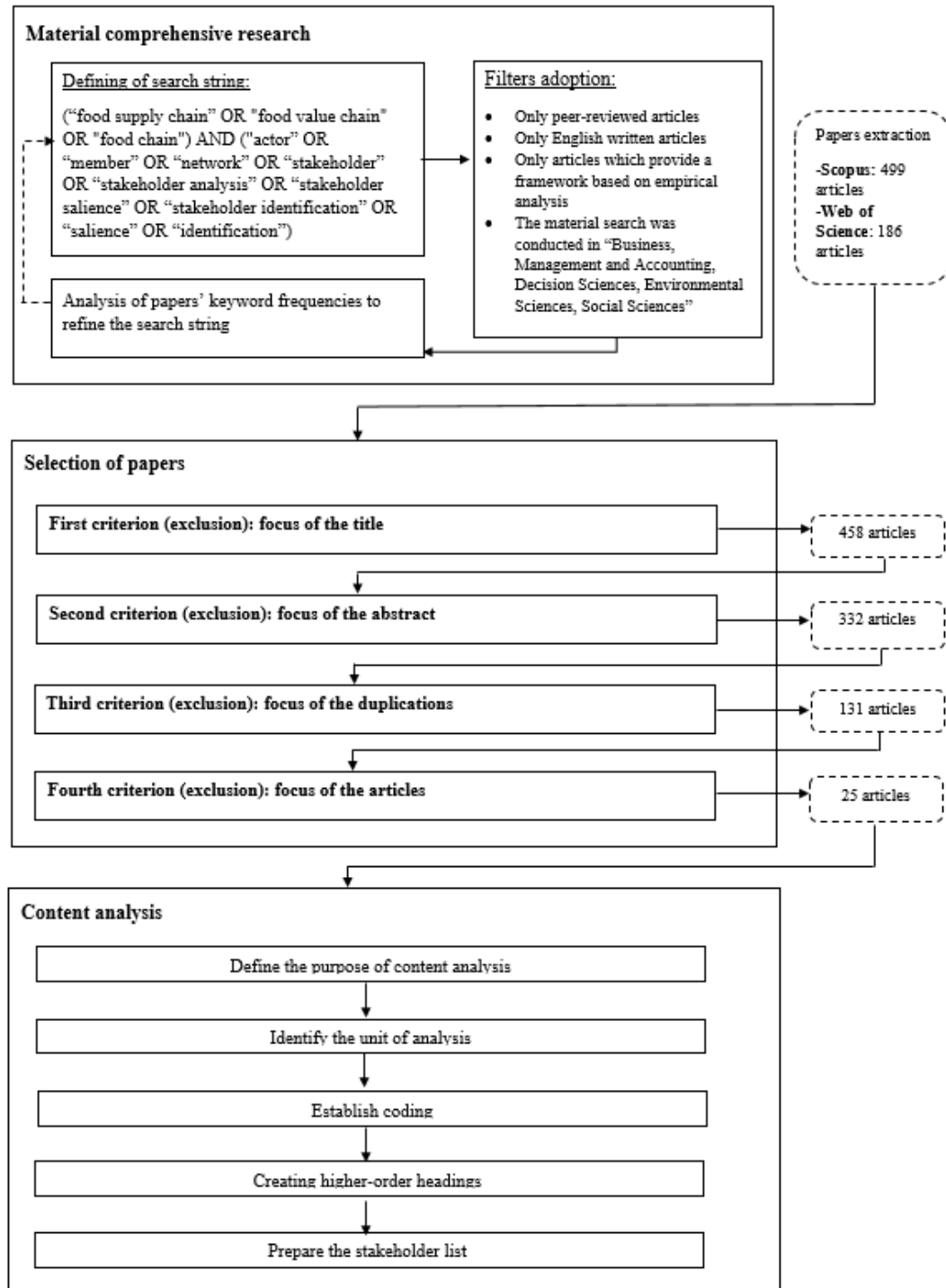
A literature review must follow a scientific and meticulous process of literature search (Petticrew and Roberts, 2006), be easily understood and replicable (Tranfield et al., 2003) and correspond to a predefined research strategy (Kitchenham, 2004). There is a need for a comprehensive protocol that clearly defines the steps to be followed (Tranfield et al., 2013). In this research, the followed protocols are outlined by Bossle et al. (2016), and Petticrew and Roberts (2006).

In the first stage, to have an overview of the food supply chain stakeholders, an exploratory stage was carried to expand on the inclusion and exclusion criteria. Some of the criteria were already set at the beginning. Only peer-reviewed and English-written articles, and articles which provide a framework based on empirical analysis were chosen. Scopus and Web of Science were chosen as the primary search databases for the literature review. Besides, a time limit restriction has been designated. Studies, which were conducted between 2000 and 2018, are included in the analysis.

An exploratory analysis was conducted in August 2018, and after that, inclusion and exclusion criteria were set to allow the last search and analysis of systematic review. “Food supply chain”, “food value chain”, “food chain”, “actor”, “member”, “network”, “stakeholder”, “stakeholder analysis”, “stakeholder salience”, “stakeholder identification”, “salience” and “identification” were the main keywords used in the exploratory analysis. Database search was conducted for “food supply chain” keyword with using the Boolean operator “AND” other keywords “actor”, “member”, “network”, “stakeholder”, “stakeholder analysis”, “stakeholder salience”, “stakeholder identification”, “salience” and “identification”. In addition, the same protocol applied for the “food value chain” and “food chain” keywords. In each database, keywords were searched on the title, abstract and keyword section of the articles. Empirical studies which either generate an FSC framework or basis the study

on an FSC framework were chosen. Figure 14 shows the research process the literature review for stakeholder analysis.

Figure 14: Systematic Literature Review Research and Content Analysis Process for Stakeholder Analysis



Resource: Compiled by author

As a result of the initial screening, 685 articles were collected from Scopus and Web of Science databases. The first step of the process was title screening. At this stage, 227 articles were excluded. Although these articles include keywords, their research focus was chemistry, biology, food science technology, and other unrelated areas. The second stage was abstract screening. At this stage, 126 articles were excluded. The articles, which do not have a holistic approach and focus on a specific part of the supply chains, were excluded at this stage. After the abstract screening, duplications -201 articles- were also excluded in this stage. As a result, 131 articles remained for article review. In the final stage, 106 more articles were excluded since they did not use empirical methods. Thus, the literature review to identify food supply chain stakeholders were completed with 25 articles.

The content analysis method was employed to analyse the extracted data. Content analysis is defined as *“a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes and patterns”* (Hsieh and Shannon, 2005). Content analysis is considered as a transparent research method (Bryman and Bell, 2011). It requires a systematic approach which enables other researchers to replicate the study (Berelson, 2000; Krippendorff, 2012). Transparency of the content analysis has enabled the method to be considered as an objective method (Bryman and Bell, 2011). Content analysis is used to identify a phenomenon, provide a detailed description of the phenomenon, and enhance the existent knowledge of the phenomenon (Moldavska and Welo, 2017). Content analysis can be applied not only unstructured information such as visual images, videos, pictures, but also qualitative case studies of organizations (Bryman and Bell, 2011). Notwithstanding, the main usage area of content analysis is to investigate media items such as annual reports, articles in the business press or academic articles (Bryman and Bell, 2011).

Content analysis can be adapted to both qualitative and quantitative research context. The quantitative content analysis focuses on answering how many questions, on the other hand, the qualitative content analysis focuses on providing an answer for categories and interpretation of the texts (Bengtsson, 2016). The purpose of quantitative content analysis is to change large data sets into concise, meaningful, organized key results (Erlingsson and Brysiewicz, 2017). In this thesis, the purpose of

context analysis was to identify stakeholder groups which occur in the different food supply chains. The second stage of the content analysis is identifying the unit of analysis (Bryman and Bell, 2011). Identified unit of analysis was the significant actors of the different food supply chains.

After the unit of analysis was identified, the next stage is coding and creating categories. Coding can be conducted either explicitly (manifest) or implicitly (latent) (Krippendorff, 2004). Explicit content-coding is interested in coding the data set considering the superficial information; on the other hand, implicit content-coding is interested in coding the data set regarding the deep mean (Berg, 2001). Explicit content-coding is preferred when the information in the data sets are clear, easily found and countable (Berg, 2001). Since the information can easily be obtained, defined and coded, explicit content-coding is considered more reliable (Babbie, 2016). If there is a need for a deeper understanding of the data set, implicit content-coding must be employed (Berg, 2001). Since implicit content-coding requires work on obscure information, ensuring reliability is difficulty (Babbie, 2016). In this dissertation, explicit content-coding was performed while coding the data set, which was extracted from the literature.

Also, coding can be completed manually or by utilizing the software. For this thesis, NVIVO12 software was utilized for coding. NVIVO12 allows to code the data into certain themes. Moreover, NVIVO12 offers to measure the frequency of codes or words and increase the rigor of the analysis (Lewins and Silver, 2007; Bazeley and Jackson, 2013). After the coding process is completed, similar codes classified together to create higher-order headings. At this stage, significant actors of the food supply chains are classified based on their job definition and named considering higher-order headings. Once the higher-order headings were prepared, the whole data set and headings were reconsidered not to overlook. Once each coded data classified under headings, the final stakeholder list was prepared.

After preparing the stakeholder list, the next stage was conducting interviews with industry members to both validate the literature review and ask them to complete stakeholder classification chart. Semi-structured interviews were conducted with FSC stakeholders for analyse stage. Semi-structured interviews are used to classify stakeholders, according to Mitchell et al. (1997)'s analytical categorization.

As a sampling method, purposive sampling was adopted. Purposive sampling is defined as “*a type of non-probability sampling in which the researcher’s judgment is used to select the sample members based on a range of possible reasons and premises*” (Saunders and Lewis, 2012). Purposive sampling was chosen because it was needed to select interviewees who are experienced and knowledgeable about the food supply chain. It is widely and commonly chosen when a relatively small sample needs to be preferred (Saunders and Lewis, 2012). While selecting the sample, the researcher needs to use his/her judgments to choose cases. Thus, this sampling method can also be named as judgmental sampling (Saunders et al., 2016). Table 8 shows the profile of the interviewees.

Table 8: Profile of the Interview Participants

Interviewee	Food Category	Type of Supplier	Title	Term of Employment within the Firm (year)	Term of Employment within the Food Industry (year)
Farmer 1	Fruit & Vegetable	Producer	Owner	45	45
Farmer 2	Fruit & Vegetable	Producer	Owner	15	15
Farmer 3	Fruit & Vegetable	Producer	Owner	8	25
FV1	Fruit & Vegetable	Frozen Food	Foreign Trade Expert	1,5	7,5
FV 4	Fruit & Vegetable	Packaged Food	General Manager	15	40
FV6	Fruit & Vegetable	Dried Food	General Manager	17	20
FV7	Fruit & Vegetable	Dried Food - Canned Food	Owner	25	25
FV8	Fruit & Vegetable	Canned Food	Total Quality Manager	3	10
FV9	Fruit & Vegetable	Canned Food	General Manager	13	27
FV10	Fruit & Vegetable	Fresh Fruit & Vegetable	Procurement Manager	8	25
M3	Meat and Meat Products, Game and Poultry	Poultry	Foreign Trade Manager	6	6

M4	Meat and Meat Products, Game and Poultry Meat and Meat Products, Game and Poultry Dairy Products	Poultry	Regional Manager	25	35
M5	Dairy Products	Meat and Meat Products	Supply Chain Manager	2	25
D3	Dairy Products	Dairy Products	Operation Manager	16	16
D4	Dairy Products	Dairy Products	Planning Manager	14	14
O1	Fats & Oils	Fats & Oils	Owner	5	5
O2	Fats & Oils	Fats & Oils	Procurement Deputy Manager	1	4
R4	Retailer	Retailer	Supply Chain Manager	8	32
W1	Wholesaler	Wholesaler	Izmir Area Manager	1	20
T1	Transportation	Transportation	Operations Executive (Sea Cargo)	3	5
T2	Transportation	Transportation	Operations Executive (Air Cargo)	< 1	4
T3	Transportation	Transportation	Operations Executive (sea - reefer)	< 1	7
P1	Packaging	Packaging	Marketing Manager	4	16
Food Security Certificate Inspector				10	20

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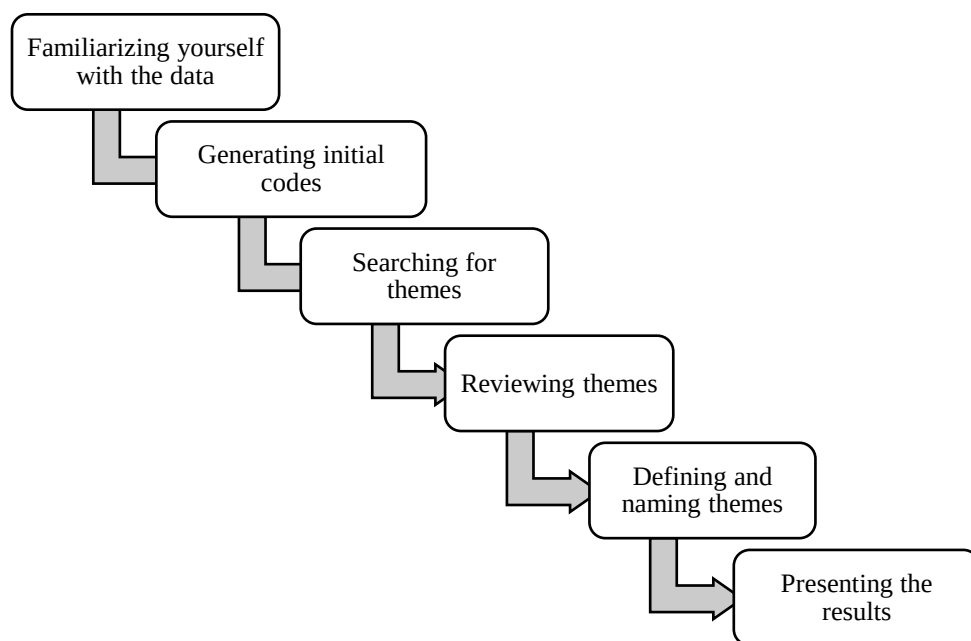
Overall, 24 interviews were conducted with different actors in the supply chain. Interviews took approximately 35 minutes to 55 minutes, and all interviews were conducted in person. All interviews were recorded. The obtained data were evaluated with a thematic analysis. Thematic analysis is defined as “*a method for identifying, analyzing and reporting patterns (themes) within data*” (Braun and Clarke, 2006; Alhojailan, 2012). Thematic analysis is a qualitative research method which is utilized for identifying, analyzing, organizing, describing, and reporting themes which are

embedded in data set (Braun and Clarke, 2006). A meticulous thematic analysis process enables trustworthy and insightful findings (Braun and Clarke, 2006).

Thematic analysis elicits to investigate different viewpoints while underpinning resemblances and variations and create unexpected understandings (King, 2004). The thematic analysis offers flexibility (Braun and Clarke, 2006). The thematic analysis offers a structured approach and clear and concise results via summarizing and extracting large data sets (King, 2004)

Thematic analysis reveals themes and concepts which are embedded in the interviews (Rubin and Rubin, 1995). The thematic analysis offers a broader understanding of a topic by conducting a systematic analysis of data (Marks and Yardley, 2004; Alhojailan, 2012). Thematic analysis is a convenient method to explore with employing interpretations (Alhojailan, 2012). The thematic analysis demonstrates the data in detail and correlates the frequency of theme with content (Boyatzis, 1998; Alhojailan, 2012). There is a constant moving back and forward between the data set, extracted codes and the analysis in the thematic analysis. The thematic analysis includes six phases. Six phases and employed phases in this thesis are shown in Figure 15.

Figure 15: Phases of Thematic Analysis



Resource: adapted from Braun and Clarke (2006)

The first phase of the thematic analysis is familiarizing with the data, which requires reading of the data, taking notes or generating an idea about the coding (Braun and Clarke, 2006). Generally, transcribing the verbal data into writing occurs at this stage. While transcribing can be considered as time-consuming, and challenging, it is very beneficial in term of familiarizing with the data (Riessman, 1993). It is also essential at this stage to start thinking about listing the ideas for initial codes. In this dissertation, to familiarize with the data, all recorded interviews were transcribed verbatim. As a result, 68 pages of transcriptions were obtained.

The second phase of the thematic analysis is generating initial codes. Codes can be defined as *“the most basic segment, or element, of the raw data or information that can be assessed in a meaningful way regarding the phenomenon”* (Boyatzis, 1998). Codes are essential for identifying key characteristics of the data, which can be semantic or latent (Braun and Clarke, 2006). Since the data converted into meaning groups with coding, the coding is considered as part of the analysis (Miles and Huberman, 1994; Tuckett, 2005).

Nevertheless, most of the times, the coded data is not as same as the theme. Coding process can be completed either manually or via using software (Lewins and Silver, 2007). In this thesis, NVIVO12 software was utilized for coding. NVIVO12 allows to code the data into specific themes. Moreover, NVIVO12 offers to measure the frequency of codes or words and increase the rigor of the analysis (Lewins and Silver, 2007; Bazeley and Jackson, 2013).

The third phase of thematic analysis is searching for themes. It starts when the aggregate data is initially coded. At the beginning of this stage, the researcher will have a long list of codes. At this stage, the researcher reunites codes according to their similarities to create themes. Simultaneously the relationship between codes, themes and different level of themes are considered at this stage (Braun and Clarke, 2006). While some of the initial codes are labelled as themes, some of them can create sub-themes. At the end of this stage, the researcher has a theme, sub-theme candidates, as well as all coded data.

The fourth phase of thematic analysis is reviewing themes. During this stage, some candidate themes will be eliminated if they do not have enough data to support, or two of themes can be converted into one (Braun and Clarke, 2006). Similarly, during

this stage candidate themes can be divided into separate themes. In this thesis, while reviewing themes, Patton (2002)'s dual criteria judging categories were considered. According to Patton (2002), internal homogeneity and external heterogeneity are key categories while identifying themes. Data within a theme should be in harmony with each other and be worthwhile, on the other hand, distinctiveness between themes must be apparent and explicit (Patton, 2002; Braun and Clarke, 2006). Thus, in this phase, two-level reviewing occurs. At the first level candidate themes and sub-themes are reviewed. Once the researcher is happy with the identified candidate themes, a candidate thematic map is prepared. At the second level, all coded data are reviewed again to ensure coherence occurs between the themes and data. Once the research is happy with the extracted data, these data are also added to the thematic map. While completing this stage, the researcher has knowledge about the terms of themes and the harmony within themes. Moreover, the researcher also has a thematic map which shows the themes and sub-themes.

The fifth phase is defining and naming themes. Once the researcher is happy with the thematic map, the fifth phase begins. At this stage, themes are defined. Specifically, the core of each theme and sub-theme are explained. Besides, the final naming of the themes and sub-themes are defined at this stage (Braun and Clarke, 2006). The last phase of the thematic analysis is presenting the results. Once the research is happy with the identified themes and sub-themes and definitions of them, the last stage begins. At this stage, research provides the result considering the research question and aims.

After the thematic analysis, stakeholder mapping is conducted with the Tsoufas et al. (2019)'s method. For this analysis, first, a stakeholder classification chart is disseminated to interviewees and asked them to complete it. The experts were interviewed to value between 0 to 4 for each stakeholder group based on the three attributes of the model (urgency, power, legitimacy). 0 means stakeholder does not have any possession for the attribute; while one means stakeholder has a low level of possession for the attribute. 2 means stakeholder has a medium level of possession for the attribute. Three means stakeholder has a high level of possession for the attribute. Four means stakeholder has a very high level of possession for the attribute. After collecting all data, median values were chosen for each attribute. During the analysis,

the median is preferred to mean, because the data was skewed. When the data is not distributed normally, the mean loses its ability to provide the best central location; on the contrary, the median still maintains its position (Laerd Statistics, 2018). Thus, while preparing the stakeholder map, the median was preferred. After the stakeholder map was completed, and stakeholders' salience was identified, stakeholder groups were also demonstrated on the Venn diagram. Lastly, based on the identified stakeholders, a generic food supply chain framework was designed.

4.2. IDENTIFICATION AND CLASSIFICATION OF LOGISTICS-RELATED CRITICAL FOOD LOSS DRIVERS

4.2.1. Different Approaches in Critical Factor Identification

Although critical factors are widely accepted and used all over the world, there is no agreed-upon method for CSF identification (Peffer et al., 2003). Thus, different methods are applied to identify critical success factors. Table 9 shows the different methods that have been applied to identify CSFs.

Table 9: Employed Methods to Identify CSFs

Research method	Reference
Case study	Sert et al. 2015; Aschemann-Witzel et al. 2017; Selitto et al. 2018
Delphi technique	Fattahi et al. 2013; Sharma et al. 2019
Interview	Zulfikar et al. 2013; Grimm et al. 2014; Radzi et al. 2016
Literature review	Talib et al. 2015; Denolf et al. 2015; Pietzsch et al. 2017
Survey	Sparkes and Thomas, 2001; Cetin et al., 2004; Nor et al. 2016
Mixed methods	Lu and Yuan, 2010; Banaeian et al. 2015; Duan et al. 2017; Shankar et al. 2018; Tu et al., 2018;

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The following six methods are commonly used to identify CSFs, case study, Delphi technique, interview, literature review, mixed methods and survey. These methods are used in different research areas such as corporate social responsibility (Sangle, 2010), sustainable supply chain management (Luthra et al., 2015a; Kannan, 2018), reverse supply chain management (Wu and Cheng, 2007), supplier selection (Cheraghi et al., 2004). However, we tried to provide examples from the food supply chain and waste literature.

The case study is employed to investigate a particular topic within its real-life context and using multiple sources of evidence (Saunders and Lewis, 2012). For example, Sert et al. (2015) employed a case study approach to explore critical factors for surplus food management from the distribution point of view. Aschemann-Witzel et al. (2017) used the case study approach to describe and investigate common and distinct key success factors for reducing consumer-related food waste in 26 existing initiatives. Selitto et al. (2018) aimed to investigate the role of critical success factors in short food supply chain via adopting a multiple case study approach. The analysis was conducted on four short food supply chain producing milk and dairy products in Italy and Brazil.

Delphi technique is another approach to reveal critical success factors. Saunders and Lewis (2012) defined Delphi technique as *“a technique which can be used with a group of people who are either involved or interested in the research topic to generate and select a more specific research idea”*. The purpose of this technique is to reach a consensus on experts' opinion on a particular subject. For instance, Fattahi et al. (2013) used Delphi method to identify critical success factors of the meat industry. Sharma et al. (2019) adopted Delphi method to identify and finalize the circular economy led to sustainability-related challenges in the food supply chain.

To identify critical factors, conducting interviews is another preferred method by the researchers. In most cases, interviews are used as a validation tool. After the researchers conduct a literature review, they validate their findings by asking factors to industry experts. For example, Zulfikar et al. (2013) adopted the semi-structured interview method to classify critical factors for a successful implementation of halal red meat supply chain in Australia. After conducting a literature review, the researcher validated the identified vital factors for experts who are in the meat industry. Grimm

et al. (2014) utilized an interview approach to identify critical factors for sub-supplier management in sustainable food supply chains. Radzi et al. (2016) employed semi-structured interviews to determine critical factors to overcome food supply chain risks occurs in Malaysia.

The literature review is mostly chosen when the researchers want to show the current snapshot of the critical factors. Researchers collect all conducted studies and based on the selection criteria, which they chose, classify dispersed factors. For instance, Talib et al. (2015) utilized literature review approach to determine critical success factors of the halal supply chain. Denolf et al. (2015) conducted a comprehensive literature review to reveal critical success factors for SC information system implementations. Pietzsch et al. (2017) employed systematic literature review method to identify benefits, challenges and critical factors of success for zero waste. As a result of the systematic literature review, they classified critical factors under six groups.

Researchers also employ survey method to identify critical success factors. For instance, Sparkes and Thomas (2001) adopted the survey method to identify critical success factors, which are required for a successful implementation of internet selling channel. Cetin et al. (2004) utilized the survey approach to define success factors for marketing via the Internet and Web sites for the Turkish agrifood small and medium-sized enterprises. Nor et al. (2016) conducted the survey method for data gathering to define critical success factors of halal food supply chain management. The analysis was based on 257 questionnaires, and as a result, six critical factors were defined.

The mixed-method combines more than one method to define critical success factors. In the literature, different combinations can be found. For example, Lu and Yuan (2010) utilized an interview and survey method together to collect data for exploring critical success factors for waste management in China. Banaeian et al. (2017) employed a mixed-method approach for selecting green raw material and packaging supplier in the food industry. In their studies, they employed both Delphi and Analytical Hierarch Process (AHP) to identify success factors (Banaeian et al., 2017). Duan et al. (2017) used a mixed-method approach. To successfully implement food traceability systems in China, researchers identified critical success factors via utilizing interviews with a survey method. Shankar et al. (2018) employed a mixed-

method approach to determine the critical success factors of traceability in the food logistics system. Thus, the survey approach and total interpretive structural modelling were combined. First success factors were determined via survey, later the relationship between factors was identified via total interpretive structural modelling. Tu et al. (2018) adopted the mixed-method approach to investigate and analyse the critical success factors of marketing ugly fruits and vegetables. After a literature review, researchers validated factors through interviews and analytical hierarchy process.

To identify and classify logistics-related critical food loss drivers, we also employed the mixed-method approach. Thus, we used a systematic literature review and interviews to fulfil the purpose. Next section gives information about the design of the identification and classification process of the logistics related critical food loss drivers.

4.2.2. Design of the Study

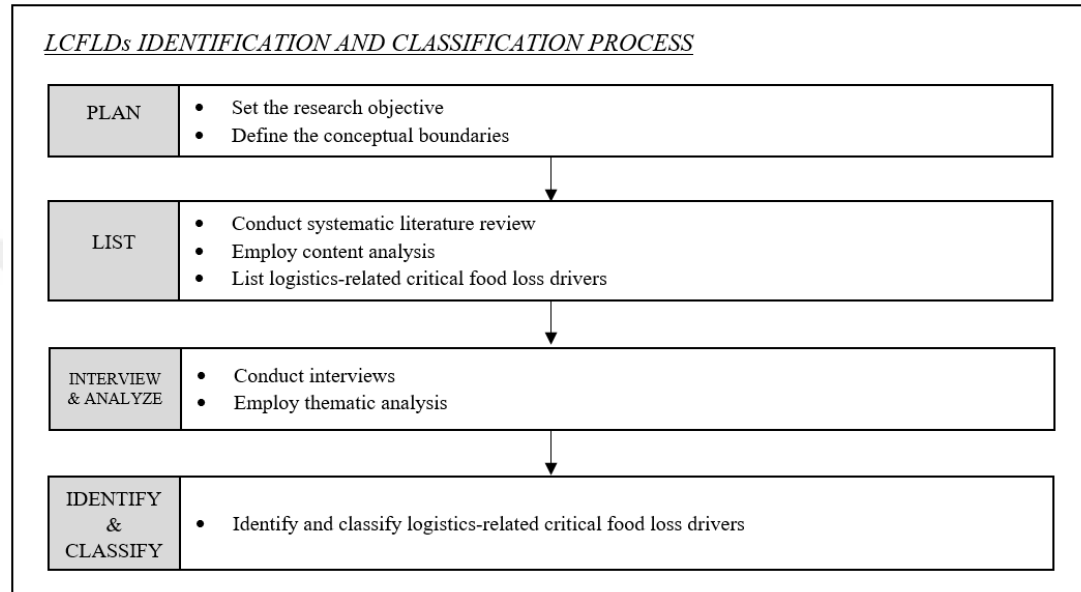
In this thesis to identify and classify logistics-related food loss drivers, the mixed-method approach was employed. First, a systematic literature review was conducted, which was followed by a semi-structured interview process. Figure 16 shows the stage of identification and classification of logistics-related critical food loss drivers.

Four stages were employed, which are plan, analyse, interview, and identify and classify, and each stage involves its steps to identify and classify logistics-related food loss drivers. The first step is the planning stage. At this stage, the research objective and the conceptual boundaries are planned. The objective of this research is to identify and classify logistics-related critical food loss drivers. Thus, it is set out to identify and analyse existing articles from the logistics viewpoint. A variety of journals and disciplines were examined to conduct this analysis. However, the analysis was only limited to academic journals. Books, book chapters, conference proceedings or industry reports weren't included.

The second stage is the analysis of the literature review. At this stage, databases were researched with the determined keywords and Boolean operators. Besides, at this stage, abstract and full-text screenings were conducted. To not to overlook any

important article, reference checking also conducted at this stage. After collecting all related articles, the articles and drivers were coded based on a logistics viewpoint. The last step in this stage is to list logistics-related critical food loss drivers considering the conducted analysis.

Figure 16: Design of the Identification and Classification of Logistics-related Food Loss Drivers



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The third stage of the study is the interview. At this stage, we wanted to verify the results of the systematic literature review to industry experts. Because since the analyzed articles' scope was international/foreign food supply chains, getting opinions of Turkish food supply chain members was vital. Thus, I have created an interview outline and asked them to food supply chain stakeholders. The interview questions can be found in the appendices (Appendix 3). Interviewed stakeholders were selected from the identified stakeholder groups in the previous step of the thesis.

The last stage is identification and classification. Based on the conducted systematic literature review and interviews, logistics-related critical food loss drivers were identified and then classified based on the food supply chain types and logistics function.

4.2.3. Data Collection and Sampling

Data was collected by utilizing two methods which are systematic literature review and interviews, to identify and classify the logistics-related critical food loss drivers. Conducting a systematic literature review allowed finding and listing all possible food loss drivers. In this section, the research and analysis process of literature review and interviews are going to be explained.

Since another literature review was also conducted for the stakeholder analysis, we followed a similar research protocol for this review as well. Thus, the research protocol was based on Bossle et al. (2016), and Petticrew and Roberts (2006).

In the first step, to have an overview of the drivers of food loss and waste, an exploratory stage was carried to expand on the inclusion and exclusion criteria. Some of the criteria were already set at the beginning such as including only peer-reviewed articles, and articles only examine food loss and food waste drivers via empirical studies through the entire or part of the FSC and only English-written articles. Besides, a time limit restriction has been designated. Studies, which were conducted between 2000 and 2018, are included in the analysis.

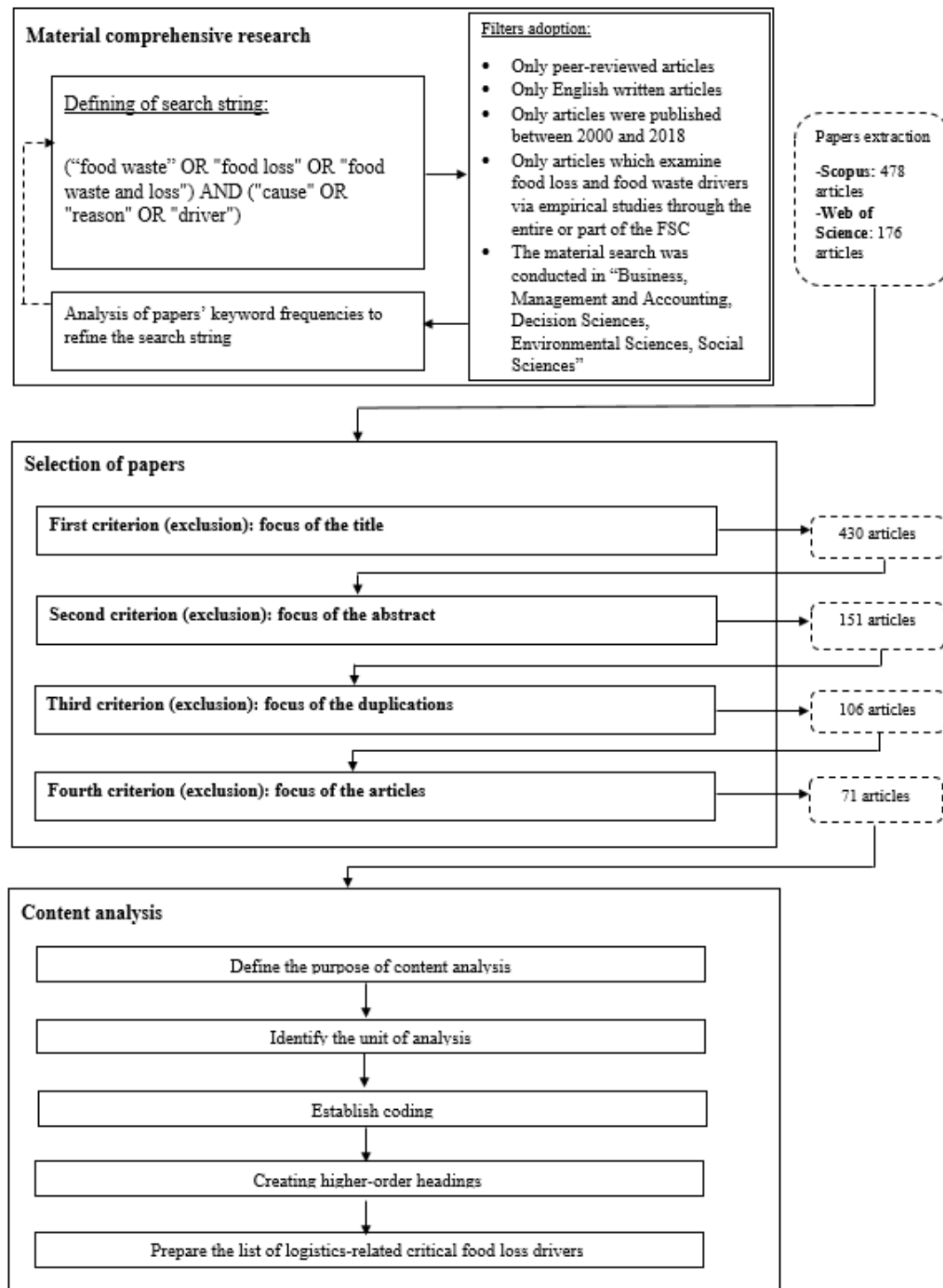
An exploratory analysis was conducted in August 2018, and after that, inclusion and exclusion criteria were set to allow the last search and analysis of systematic review. "Food waste", "food loss", "food waste and loss", "cause", "driver" and "reason" were the main keywords used in the exploratory analysis. At first, research was conducted for "food waste" keyword with using the Boolean operator "AND" databases were scanned with other keywords "cause", "reason" and "driver", respectively. Same protocol applied for the "food loss" and "food loss and waste" keywords, as well. Keyword scanning conducted on title, abstract and keywords. In this research, more than one database used to compare results and get an overall perspective on the subject. Thus, the systematic literature review was conducted on both Scopus and Web of Science. Figure 17 shows the research process of the systematic literature review for food loss drivers.

As a result of the initial screening, 654 articles were collected from Scopus and Web of Science databases. The first step of the process was title screening. At this stage, 224 articles were excluded. Although these articles include keywords, their

research focus was chemistry, biology, food science technology; the second stage was abstract screening. At this stage, 279 articles were excluded. The articles, which do not have a holistic approach and focus on a specific part of the supply chains, were excluded at this stage. Moreover, during this stage, a duplication check was completed and duplications, which are 45 articles, were also excluded. As a result, 106 articles remained for article review. At this final stage, 35 more articles were excluded since they did not use empirical methods or did not have any food loss drivers. Thus, the literature review to identify food supply chain stakeholders were completed with 71 articles. Extracted systematic literature review data were analysed with content analysis.



Figure 17: Systematic Literature Review and Content Analysis Process for Food Loss Driver Identification



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For the content analysis to identify LCFLDs, similar stages were followed as it is conducted for stakeholder analysis. The first stage of the content analysis was to identify the purpose of the analysis (Erlingsson and Brysiewicz, 2017). In this thesis, the purpose of the context analysis was to identify the logistics-related critical food loss drivers for different food supply chains. The second stage of the content analysis is identifying the unit of analysis (Bryman and Bell, 2011). Identified unit of analysis was the organizations which are dealing with food loss. Specifically, food supply chain members who are suppliers, producers, manufacturers, traders, distributors, wholesalers, retailers and retailer shops were included in analysis. Food services and households were not included in the analysis. After the unit of analysis was identified, the next stage is coding and creating categories. Coding can be conducted either explicitly (manifest) or implicitly (latent) (Krippendorff, 2004). In this dissertation, explicit content-coding was performed while coding the data set, which was extracted from the literature. Furthermore, NVIVO 12 software was utilized while completing the coding. After the coding process is completed, similar codes classified together to create higher-order headings. At this stage, significant actors of the food supply chains are classified based on their job definition and named considering higher-order headings. Once the higher-order headings were prepared, the whole data set and headings were reconsidered not to overlook. Once each coded data classified under headings, the list of logistics-related critical food loss drivers was prepared.

Although all reviewed articles focused on the FSCs, articles were conducted in different countries and regions. Therefore, it is essential to identify whether the identified LCFLDs also occur in the Turkish FSCs. Conducting interviews was the second stage of the identification and classification of logistics-related critical food loss drivers. The interview method was applied to validate the LCFLDs which were found through the systematic literature review.

Since interviewing with the whole members of the Turkish food supply chain is impracticable, we conducted interviews with a sample. Non-probability sampling is used when the probability of each case chosen from the target population is not known (Saunders et al., 2016). To be sure of interviewees were the right experts and were qualified to answer the research questions, judgmental sampling was chosen (Malhotra, 2008).

A total of 39 interviews were conducted. The sample size was sufficient since we reached theoretical saturation during the last interviews (Strauss and Corbin, 1998). Moreover, Guest et al. (2006) and Boddy et al. (2016) noted that 12 in-depth interviews sufficient in the homogeneous group to reach saturation points while Creswell (2013) and Saunders (2012) mentioned that between 5 to 30 interviews sufficient in heterogeneous groups to reach theoretical saturation. The profile of the interviewees is shown in Table 10.

A total ten interview was conducted with fruit and vegetable processors who produce frozen, packaged, dried, canned and fresh fruit and vegetables. Third interviews were conducted with farmers who sell their products to wholesaler, fruit and vegetable producers and retailers. Five interviews were conducted with meat and poultry producers. Five interviews were conducted with dairy product producers. One interview was done with a wholesaler who has the biggest distribution network in the Aegean region. A total of four interviews was conducted with food retailers. Four interviews were conducted with experts from the transportation industry, who were only specialized in food transportation. Two interviews were conducted with fats and oil producers. For fish, shellfish and molluscs industry, one interview was conducted. One interview was conducted for the bakery industry.

Table 10: Profile of the Interviewees

Interviewee	Food Category	Type of Supplier	Title	Term of Employment within the Firm (year)	Term of Employment within the Food Industry (year)	Export /Domestic Market
Farmer 1	Fruit & Vegetable	Producer	Owner	45	45	N/A
Farmer 2	Fruit & Vegetable	Producer	Owner	15	15	N/A
Farmer 3	Fruit & Vegetable	Producer	Owner	8	25	N/A
FV1	Fruit & Vegetable	Frozen Food	Foreign Trade Expert	1,5	7,5	Both
FV2	Fruit & Vegetable	Packaged Food	Owner	4,5	20	Export Only
FV3	Fruit & Vegetable	Packaged Food	General Manager	< 1	14	Both
FV 4	Fruit & Vegetable	Packaged Food	General Manager	15	40	Both
FV5	Fruit & Vegetable	Packaged Food	Sales Manager	15	25	Both
FV6	Fruit & Vegetable	Dried Food	General Manager	17	20	Export Only
FV7	Fruit & Vegetable	Dried Food - Canned Food	Manager	25	25	Export Only
FV8	Fruit & Vegetable	Canned Food	Owner Total Quality Manager	3	10	Export Only
FV9	Fruit & Vegetable	Canned Food	General Manager	13	27	Export Only

FV10	Fruit & Vegetable	Fresh Fruit & Vegetable	Procurement Manager	8	25	Both
M1	Meat and Meat Products, Game and Poultry	Poultry	Logistics Manager	4,5	17	Both
M2	Meat and Meat Products, Game and Poultry	Poultry	Food Engineer	2	5,5	Both
M3	Meat and Meat Products, Game and Poultry	Poultry	Foreign Trade Manager	6	6	Domestic Market Only
M4	Meat and Meat Products, Game and Poultry	Poultry	Regional Manager	25	35	Both
M5	Meat and Meat Products, Game and Poultry	Meat and Meat Products	Supply Chain Manager	2	25	Both
F1	Fish, Shellfish and Mollusks	Fish, Shellfish and Mollusks	Production Manager	7	10	Both
D1	Dairy Products	Dairy Products	Procurement Manager	10	25	Both
D2	Dairy Products	Dairy Products	Procurement Manager	15	25	Both
D3	Dairy Products	Dairy Products	Operation Manager	16	16	Both
D4	Dairy Products	Dairy Products	Planning Manager	14	14	Both
D5	Dairy Products	Dairy Products	Owner	4	8	Domestic Market Only

O1	Fats & Oils	Fats & Oils	Owner Procurement Deputy	5	5	Domestic Market Only Both
O2	Fats & Oils	Fats & Oils	Manager Supply Chain	1	4	N/A
R1	Retailer	Retailer	Manager Supply Chain	5	15	N/A
R2	Retailer	Retailer	(Retired) Supply Chain	5,5	32	N/A
R3	Retailer	Retailer	Manager Supply Chain	5	32	N/A
R4	Retailer	Retailer	Manager Izmir Area	8	32	N/A
W1	Wholesaler	Wholesaler	Manager Supply Chain Deputy	1	20	Both
B1	Bakery	Bakery	Manager Operations Executive	3,5	10	N/A
T1	Transportation	Transportation	(Sea Cargo) Operations Executive	3	5	N/A
T2	Transportation	Transportation	(Air Cargo) Operations Executive	< 1	4	N/A
T3	Transportation	Transportation	(sea - reefer)	< 1	7	

			Operation Manager (cold chain) Marketing Manager			N/A
T4	Transportation	Transportation		1,5	20	
P1	Packaging	Packaging		4	16	Both
Food Security Certificate Inspector Board Member of Aegean Exporters' Associations (Fruit & Vegetable)						N/A
				10	20	N/A
				11	25	

Resource: Compiled by author

Besides these interviews, three more interviews were conducted to validate the interviews and gain insights into the food industry. Thus, one interview was conducted with a packaging producer who provides packaging materials for all interviewed firms. One interview was conducted with food security certificate inspector, and one interview was conducted with a board member of Aegean Export Associations.

Interviews can be conducted with a variety of methods such as face-to-face interviews, telephone interviews, internet-mediated interviews and focus group interviews. In a face-to-face interview, the researcher directly communicates with the interviewee. Moreover, during the interview process, the researcher is also able to make observations about the interviewee and capture emotions, behaviours, and non-verbal cues. However, it can be costly, time-consuming and limit sample size since. The telephone interview is another option to collect data and especially beneficial when the researcher and interviewee were not able to meet because of the distance and time issues.

In this research, data were collected via face-to-face and telephone interviews. A total of 27 interviews was conducted as face-to-face interviews, and 12 of them was conducted as telephone interviews. All the interviews were conducted in June and July 2019. All interviews were tape-recorded. Overall, 1329 minutes of voice recording was collected.

The obtained data were analysed with thematic analysis. It is a qualitative research method which is utilized for identifying, analysing, organizing, describing, and reporting themes which are embedded in data set (Braun and Clarke, 2006). The same thematic analysis phases that were utilized for stakeholder analysis also employed for the identification and classification of the LCFLDs.

The first stage of the thematic analysis is familiarizing with the data (Braun and Clarke, 2006). One of the ways of doing this, transcribing the data. Thus, in this dissertation, to familiarize with the data, all recorded interviews were transcribed verbatim. As a result, 184 pages of transcriptions were obtained. The second phase of the thematic analysis is generating initial codes. In this thesis, NVIVO12 software was utilized for coding. The third phase of thematic analysis is searching for themes. Once the initial coding is completed, the phase of searching themes begin. At this stage, the researcher reunites codes according to their similarities to create themes.

Simultaneously the relationship between codes, themes and different level of themes are considered at this stage (Braun and Clarke, 2006). While some of the initial codes are labelled as themes, some of them can create sub-themes. At the end of this stage, the researcher has a theme, sub-theme candidates, as well as all coded data.

The fourth phase of thematic analysis is reviewing themes. During this stage, some candidate themes will be eliminated if they do not have enough data to support, or two of themes can be converted into one (Braun and Clarke, 2006). While completing this stage, the researcher has knowledge about the terms of themes and the harmony within themes. Moreover, the researcher also has a thematic map which shows the themes and sub-themes. The fifth phase is defining and naming themes. Once the researcher is happy with the thematic map, the fifth phase begins. At this stage, themes are defined. The last phase of the thematic analysis is presenting the results. Once the research is happy with the identified themes and sub-themes and definitions of them, the last stage begins. At the last stage, the main themes and sub-themes were explained. The result of the thematic analysis was provided in next chapter.

4.3. PRIORITIZATION OF LOGISTICS-RELATED CRITICAL FOOD LOSS DRIVERS

4.3.1. Different Approaches in Prioritization of Critical Factors

It is required to know which drivers have more impact on the loss amount, to diminish the amount of food loss. Thus, ranking the logistics-related critical food loss drivers according to their impact level is crucial. Thus, we need to rank food loss drivers according to their impact level. In the literature, different methods have been applied to rank critical factors. Table 11 shows the commonly employed methods for ranking critical factors.

The following methods are commonly used to prioritize CSFs. AHP, ANP, TOPSIS, fuzzy version of the methods and mixed-methodology. These methods were employed in different research areas such as reverse logistics (Bahieaei et al., 2015;

Agrawal et al., 2016), total quality management (Mehralian et al., 2016) and food chain (Omar and Rahman, 2015; Mor et al., 2017).

Table 11: Employed Methods to Rank Critical Factors

Research method		Reference
Analytical Hierarchy Process (AHP)	Hierarchy	Omar and Rahman, 2015; Chin et al., 2008; Mor et al. 2017; Yang et al. 2018
Analytical Network Process (ANP)	Network	Chauhan et al. 2019
TOPSIS		Bahiraie et al. 2015; Mehralian et al. 2016
Fuzzy AHP		Tseng et al., 2008; Somsuk and Simcharoen, 2011
Fuzzy TOPSIS		Agrawal et al. 2016; Gupta et al. 2018
Mixed-methodology		Folinas et al. 2015; Mangla et al., 2016

Resource: Compiled by author

One of the prioritization methods is AHP, and it is widely used in the literature. Detailed information about AHP is going to be provided in the next section. For instance, Omar and Rahman (2015) employed the analytical hierarchy process to identify critical success factors of halal food supply chains with four criteria and thirteen sub-criteria. Chin et al. (2008) employed the AHP method to identify and prioritize CSFs for cooperation strategy management in Hong Kong manufacturing. For this purpose, the authors classified three factors and 17 sub-factors, and six experts completed the AHP questionnaire. Mor et al. (2017) conducted a study on the dairy supply chain to identify the critical factors which lead to low-productivity. They gathered 32 critical factors and conducted AHP analysis with 22 experts from both academics and the dairy industry. Yang et al. (2018) identified four criteria, and nineteen sub-criteria to increase farmers' competitiveness, to develop the organic agricultural industry. Later, researchers employed the AHP method to rank the criteria.

Another approach that is used to prioritize CSFs is Analytical Network Process (ANP). ANP is used to *“derive relative priority scales of absolute numbers from individual judgments that also belong to a fundamental scale of absolute numbers”* Saaty (2004). The structure of AHP is hierarchical; while the structure of ANP is a

network (Saaty 2004). Thus, while examining the factors and sub-factors which have relationships with each other ANP method is preferred. For instance, Chauhan et al. (2019) defined vital enablers to improve relationships between supply chain partners, and the selected enablers were used to rank the alternative supply chains for agri-produce with the help of analytical network process (ANP).

Technique for order preference by similarity to ideal solution (TOPSIS) is another method to prioritize CFSs. TOPSIS is a multi-criteria decision modelling, is based on the concept that chosen alternative should have the shortest geometric distance from the positive ideal solution and the longest geometric distance from the negative ideal solution (Assari et al., 2012). The method can also be applied to prioritization of the factors. For instance, Bahiraei et al. (2015) employed the TOPSIS method to rank CSFs, which were essential for implementing reverse logistics practices. Mehralian et al. (2016) utilized the TOPSIS method to identify and prioritize CSFs within the pharmaceutical industry while enabling the successful application of total quality management.

Likewise, AHP and TOPSIS, fuzzy logic and MCDM can be combined and used to prioritize the factors. The rationale behind the fuzzy logic is the viewpoint of people make decisions based on incorrect and non-numerical information (Yilmaz et al., 2001). Fuzzy models present this unclarity and incorrect information. Thus, in fuzzy logic, real values of variables vary between 0 and 1 (Yilmaz et al., 2001). Fuzzy logic with combining multi-criteria decision modelling is employed to prioritize the CSFs. For example, Somsuk and Simcharoen (2011) used fuzzy AHP to prioritize CSFs for six sigma implementation. Tseng et al. (2008) utilized a fuzzy AHP method to identify and prioritize CFS in environmental uncertainty while maintaining the TQM strategy. Agrawal et al. (2016) defined 12 CSFs through literature review, which are essential to reverse logistics implementation in the Indian electronics industry. To prioritize the CSFs, authors used the fuzzy TOPSIS method. Gupta et al. (2018) used fuzzy TOPSIS method to determine the rate of the importance of identified CSFs. By conducting the literature review, the authors identified 12 CSFs and evaluated the questionnaire to 5 participants from different industries.

The mixed-method combines more than one method to prioritize critical success factors. In the literature, different combinations can be found. For instance,

Folinas et al. (2015) utilized AHP and data envelopment analysis (DEA) to identify and prioritize critical logistics process in the agri-food sector. In their study, they identified eight critical factors and 56 sub-factors. 57 expert from different firms completed the questionnaire. Similarly, Mangla et al. (2016) employed AHP and DEMATEL approach to evaluate CSFs in reverse logistics adoption in Indian manufacturing industries.

In this thesis, to prioritize logistics-related critical food loss drivers, the AHP method was employed. Next section provides information about the design of the method and mathematical notion of the method.

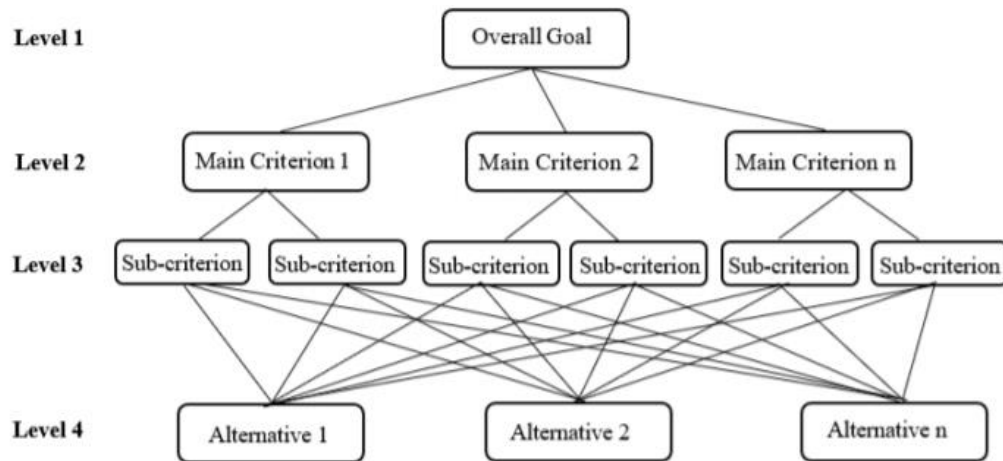
4.3.2. Design of the Study

4.3.2.1. Analytical Hierarchy Process

Multi-criteria decision methods (MCDMs) were developed in the 1960s to help organizations to make decisions. MCDM can be defined as problems in which the best alternative is chosen among the possible solution sets where multiple criteria are optimized (Tzeng and Huang, 2011). According to another definition, MCDM includes tools that are widely used in decision analysis, evaluating more than one decision criteria and enabling selection between alternatives, grouping or limiting alternatives (Timor, 2011). MCDM are tools that allow including multiple experts into the analysis while enabling to evaluate measurable and unmeasurable strategic and operational factors at the same time (Gorener, 2009). The primary purposes of using MCDM is (1) to control the decision-making mechanism when the number of alternatives and criteria are too much and (2) to obtain the best decision within the shortest possible time and precisely. There are different MCDM in the literature. AHP is considered one of the multi-criteria decision method.

Thomas L. Saaty developed AHP at Wharton School of Business in 1970 as a multi-criteria decision method. AHP tries to find out the best decision between many different ways. AHP is a technique that provides ranking by analyzing the ideas of decision-makers (experts) in determining the relative importance of all criteria. Representation of hierarchical AHP is demonstrated in Figure 18.

Figure 18: Sample Hierarchical Representation



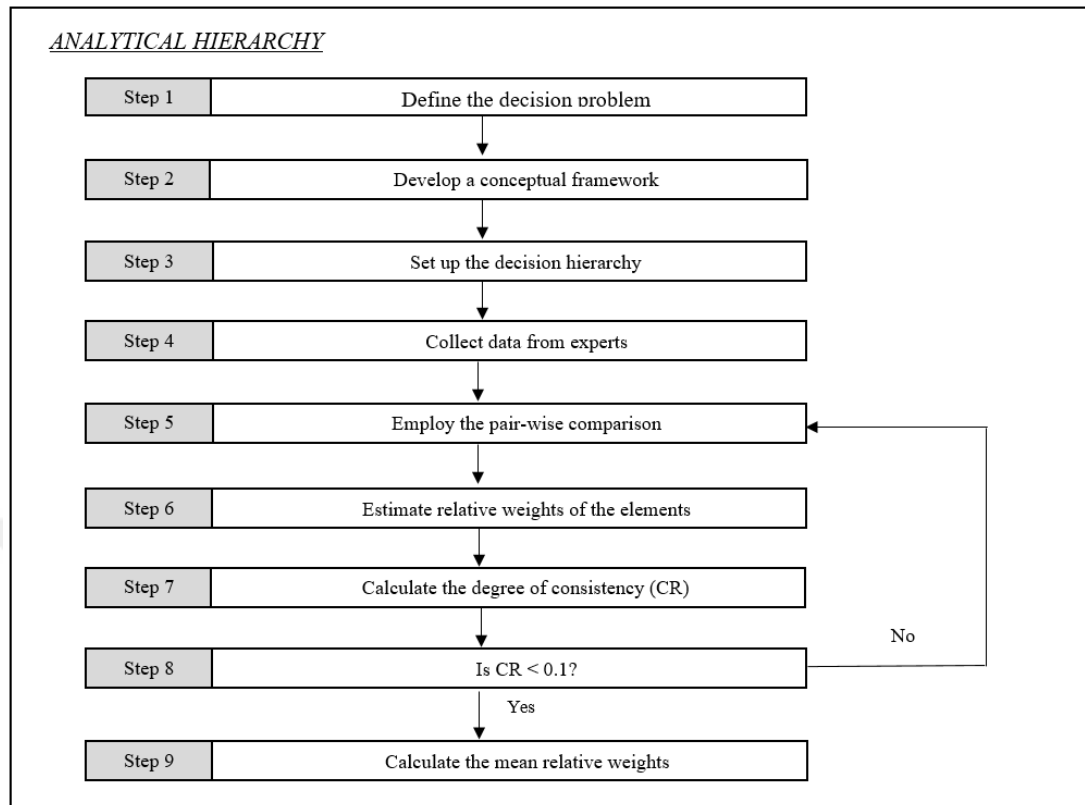
Resource: Saaty, 1999

Experts make pairwise comparisons for all criteria and sub-criteria with using AHP survey. In an AHP survey, Saaty's nine-point scale (major scale) is used. Order of priority is calculated by evaluating all criteria and sub-criteria (Niemira and Saaty, 2006).

AHP can be applied to complex problems because the method breaks down decision problem into hierarchical layers (Macharis et al., 2004). This feature enables clarity for each criterion and sub-criterion. AHP is a flexible method (Yildirim and Onder, 2014). The method can be applied to a wide variety of problems. Generally, researchers and experts consider the pairwise comparison as straightforward and user-friendly. Besides, AHP offers inconsistency checking (Ramanathan, 2001). AHP method supports group-decision making because each pairwise comparisons are combined via geometric mean (Zahir, 1999).

AHP provides ease of operations by reducing the multi-dimensional problems to one dimension by finding the importance of the criteria and sub-criteria. AHP priorities the criteria and sub-criteria in complex environments decision-making process. AHP is used to identify decision hierarchy and is a decision-making and estimation method that gives percentage distribution of decision points in terms of factors affecting the decision. A nine-step procedure for AHP is formulated for this dissertation and schematically provided in Figure 19.

Figure 19: Design of AHP Method



Resource: Compiled by author

The first step of the AHP method is to define the decision problem. The decision problem is identifying logistics-related critical food loss drivers, which cause more food loss in the food supply chain. The second step is developing a conceptual framework. Based on this research problem, for each food supply chain, a conceptual framework is developed. Details of each conceptual framework can be found in the next chapter. After conceptual framework development, the next stage is setting up the decision hierarchy. The decision hierarchy consists of 3 criteria and 11 sub-criteria, for fats and oil supply chain. For the dairy supply chain, the decision hierarchy consists of 3 criteria and 11 sub-criteria. For meat and sausage supply chain, the decision hierarchy consists of 4 criteria and 13 sub-criteria. For vegetable and fruit supply chain, the decision hierarchy consists of 3 criteria and 13 sub-criteria.

The fourth step is collecting data from experts. For this step, first, an AHP questionnaire is created for each food supply chain type. The AHP questionnaire, is prepared for each food supply chain type. Template of the AHP questionnaire can be

found in the appendices (Appendix 4). To design comparison questions, Lirn et al. (2004)'s questionnaire design approach is adopted. Then to collect data, prepared questionnaires were sent to industry experts. The demographics of the experts for each food supply chain is explained in the next section. The base ratings were obtained by taking the geometric mean of each respondents' final ratings (Saaty, 2008; Vishnu et al., 2019). After taking the geometric mean, then the analysis stage began. However, thus, based on the collected data, pair-wise comparisons matrix are prepared, which is followed by estimating relative weights of elements. Lastly, the degree of consistency is calculated by the consistency ratio (CR). If the CR is equal or lower than 0.1, this means that the experts provided consistent viewpoints and analysis can continue with calculating the mean relative weights. However, if the CR is higher than 0.1, meaning that no consistency can be found between experts' opinion, thus more data (from different experts) needs to be collected and the analysis needs to be re-conducted. The mathematical notation of the method is going to be explained next.

4.3.2.2. Mathematical Notation of Analytical Hierarchy Process

The weights of criteria (w) are determined at the end of pairwise comparisons. For pairwise comparisons, the Saaty's fundamental scale is used. Table 12 shows Saaty's nine-point scale.

Table 12: Saaty's Fundamental Scale

Intensity of importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Moderate importance	Experience and judgement slightly favour one activity over another
5	Strong importance	Experience and judgement strongly favour one activity over another
7	Very strong importance	One activity is strongly favoured over another

9	Extremely important	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 judgments	They are used to express preferences that are between the values of the above scale
Reciprocal Values	If activity i has one of the above nonzero numbers assigned to it when compared activity j , then j has the reciprocal value when compared with i	

Resource: Saaty, 1980

While calculating AHP, the upper limit is set as nine. The reasons for this decision are:

- i. AHP works at best when the number of criteria is lower than 10 ($n < 10$),
- ii. If a matrix consists of too many big numbers, inconsistencies can occur

All comparison values are positive. In comparison matrix, diagonal cells get the one value. Diagonal cells get one because each criterion is compared with itself.

If the criteria are $a_1, a_2, \dots, a_n$ and the weights are $w_1, w_2, \dots, w_n$. If n criteria are asked to make a pairwise comparison based on the importance level, the pairwise comparison matrix is seen as the following (Tzeng and Huang, 2011).

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ \cdot & & & \cdot \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \quad (1)$$

a_{ij} becomes $\frac{1}{a_{ji}}$ because of the reciprocity feature. Similarly, a_{ij} becomes $\frac{a_{ik}}{a_{jk}}$. In

real problems, the result of the equation of $\frac{w_i}{w_j}$ is unknown. Thus, in AHP, a_{ij} value is expected to calculate (Tzeng and Huang, 2011). The demonstration of the weight matrix is shown below.

$$W = \begin{matrix} & \begin{matrix} w_1 & & w_j & & w_n \end{matrix} \\ \begin{matrix} w_1 \\ \vdots \\ w_i \\ \vdots \\ w_n \end{matrix} & \begin{bmatrix} w_1/w_1 & \dots & w_1/w_j & \dots & w_1/w_n \\ \vdots & & \vdots & & \vdots \\ w_i/w_1 & \dots & w_i/w_j & \dots & w_i/w_n \\ \vdots & & \vdots & & \vdots \\ \vdots & & \vdots & & \vdots \\ w_n/w_1 & \dots & w_n/w_j & \dots & w_n/w_n \end{bmatrix} \end{matrix} \quad (2)$$

Multiplying W and w values,

$$A. w = \begin{matrix} & \begin{matrix} w_1 & & w_j & & w_n \end{matrix} \\ \begin{matrix} w_1 \\ \vdots \\ w_i \\ \vdots \\ w_n \end{matrix} & \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \vdots & \dots & \vdots & \dots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} \end{matrix} \begin{bmatrix} w_1 \\ \vdots \\ w_i \\ \vdots \\ w_n \end{bmatrix} = n \begin{bmatrix} w_1 \\ \vdots \\ w_i \\ \vdots \\ w_n \end{bmatrix} \quad (3)$$

Alternatively, it can be demonstrated as follows:

$$(W - nI)w = 0 \quad (4)$$

The solution of the equation above is the eigenvalue. Relative weights are calculated with the eigenvector w based on λ_{Maks} , which provides the equation $Aw = \lambda_{\text{Maks}} w$. Here λ_{Maks} is the largest eigenvalue of the A matrix, and w eigenvector is obtained with $(W - nI)w = 0$ equation.

Moreover, two coefficients, the Consistency Index (CI) and the Consistency Ratio (CR) are calculated to ensure the consistency of subjective perceptions and the accuracy of relative weights. The following formula is used to calculate the Consistency Index (CI).

$$CI = \frac{(\lambda_{\text{Maks}} - n)}{(n-1)} \quad (5)$$

In this formula, λ_{Maks} is the average value of each λ_i value and n is the number of criteria. The CI value must be equal to or lower than 0.1 to reach a reliable result (Tzeng and Huang, 2011). The following formula is used to calculate CR.

$$CR = \frac{CI}{RI} \quad (6)$$

RI means Random Inconsistency Index. RI is average inconsistency calculated by randomly generated matrices for the same dimensions. The most commonly used RI values are proposed by Saaty (1980) and shown in Table 13.

Table 13: RI Values Proposed by Saaty

	Matrix Dimension (n)								
	3	4	5	6	7	8	9	10	11
RI	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49	1,51

Resource: Saaty (1980)

To reach reliable results, CR must be equal to or lower than 0,1. It is accepted that the closer to zero is the CR, the more consistent the experts' responses (Tzeng and Huang, 2011). If the CR is more significant than 0,1, two things can happen. Either the number of experts' responses must be increased or response, which includes outlier values, must be taken off.

4.3.3. Sampling of Analytical Hierarchy Process

This thesis adopted the purposive sampling technique while selecting experts to complete the AHP questionnaire. Purposive sampling, which is defined as “*a type of non-probability sampling in which the researcher’s judgment is used to select the sample members based on a range of possible reasons and premises*” (Saunders and Lewis, 2012). It is widely and commonly chosen when a relatively small sample needs

to be preferred (Saunders and Lewis, 2012). While selecting the sample, the researcher needs to use his/her judgments to choose cases. Thus, this sampling method can also be named as judgmental sampling (Saunders et al., 2016). In the literature, there are several studies which conducted their studies with a variety number of experts. For instance, Omar and Rahman (2015) included ten experts in their study. Sofyalioglu and Surucu (2018) used four experts to conduct AHP analysis. Chin et al. (2008) asked six experts to complete the AHP questionnaire. Mor et al. (2017) employed 22 experts to conduct AHP. In terms of the number of experts, which should participate in the study, there is no consensus. However, we can make an inference in terms of the minimum number of expert. The minimum number of the expert must be three because any expert number lower than three will give incorrect response considering the value of RI.

For each food supply chain type, different AHP questionnaire is prepared based on the criteria and sub-criteria and sent to industry experts. The questionnaire was distributed and collected 15 October – 15 December 2019. For each supply chain type, different number of experts completed the questionnaire. Seven experts completed the AHP questionnaire for fats and oil supply chain. Table 14 shows the demographics of the experts.

Table 14: Demographics of the Fats and Oil Supply Chain Experts

	Experienc e in the firm (Years)	Experie nce in the industry (Years)	Position	Production amount (monthly- tonnes)	Trading type	
Expert 1	5	5	Owner	2,000	Local Export	/
Expert 2	8	12	Supply Chain Manager	2,500	Local Export/ Import	/
Expert 3	1	4	Procurement Deputy Manager	2,700	Local Export Import	/

Expert 4	2	5	Logistics Deputy Manager	2,700	Local Export Import	/
Expert 5	2	2	Operations Specialist	2,700	Local Export Import	/
Expert 6	4	4	Planning Deputy Manager	2,500	Local Export/ Import	/
Expert 7	3	7	Inventory Deputy Manager	2,500	Local Export/ Import	/

Resource: Compiled by author

Eleven experts from the dairy supply chain completed the AHP questionnaire. Table 15 shows the demographics of the experts.

Table 15: Demographics of the Milk and Dairy Product Food Supply Chain Experts

	Experience in the firm (Years)	Experience in the industry (Years)	Position	Production amount (monthly- tonnes)	Trading type	
Expert 1	7	15	Planning Manager	30,000	Local	
Expert 2	15	15	Planning Manager	36,000	Export Local	/
Expert 3	20	20	Logistics Manager	30.000	Local	
Expert 4	22	22	Inventory Deputy Manager	36.000	Export Local	/
Expert 5	4	10	Distribution Deputy Manager	30.000	Local	
Expert 6	7	12	Distribution Manager	30.000	Local	

Expert 7	16	16	Operation Manager	90.000	Local Export	/
Expert 8	10	25	Operation Manager	15.000	Local Export	/
Expert 9	10	14	Supply Chain Manager	90.000	Local Export	/
Expert 10	2	10	Supply Chain Manager	45.000	Local Export	/
Expert 11	7	15	Supply Chain Manager	60.000	Local/ Export	

Resource: Compiled by author

Fourteen experts from meat and poultry supply chain completed the AHP questionnaire. Table 16 shows the demographics of the experts.

Table 16: Demographics of the Meat and Poultry Supply Chain Experts

	Experience in the firm (Years)	Experience in the industry (Years)	Position	Production amount (monthly- tonnes)	Trading type	
Expert 1	2	25	Supply Chain Manager	10,000	Export Import Local	/
Expert 2	3	7	Logistics Manager	17,000	Export Import/ Local	/
Expert 3	10	17	General Manager	17,000	Export Import/ Local	/
Expert 4	6	6	Foreign Trade Manager	23,000	Export/ Import Local	/
Expert 5	25	35	Regional Manager	10,000	Export Import/ Local	/

Expert 6	4	6	Operations Deputy Manager	3,500	Export Import Local	/ /
Expert 7	7	16	Logistics Manager	23,000	Export Import/ Local	/
Expert 8	4	8	Logistics Manager	30,000	Export Import/ Local	/
Expert 9	21	25	General Manager	50,000	Import/ Local/ Export	
Expert 10	3	5	Operations Manager	30,000	Export Import Local	/ /
Expert 11	6	16	Supply Chain Coordinator	50,000	Import Local/ Export	/
Expert 12	4	4	Operations Manager	50,000	Import Local	/
Expert 13	9	9	Logistics Deputy Manager	90,000	Import Local	/
Expert 14	12	20	Supply Chain Manager	90,000		

Nineteen experts from vegetable and fruit supply chain completed the AHP questionnaire. Table 17 shows the demographics of the experts.

Table 17: Demographics of Fruit and Vegetable Supply Chain Experts

	Experience in the firm (Years)	Experience in the industry (Years)	Position	Production amount (monthly- tonnes)	Trading type	
Expert 1	0,75	0,75	Quality Control Manager	730	Export Import Local	/ /

Expert 2	1	34	General Manager	350	Export Import/ Local	/
Expert 3	9	9	Deputy Supply Chain Manager	100	Export Import	/
Expert 4	7	10	Procurement Manager	750	Export	
Expert 5	7	15	Operation Manager	100	Export	
Expert 6	17	21	General Manager	125	Export	
Expert 7	21	38	General Manager	1.375	Export	
Expert 8	5	21	Owner	45	Export	
Expert 9	1	15	General Manager	100	Export	
Expert 10	15	25	Sales Manager	3000	Export Local	/
Expert 11	20	40	General Manager	3000	Export/ Local	
Expert 12	8	25	Procurement Manager	1750	Export	
Expert 13	14	14	Supply Chain Manager	700	Export Import Local	/ /
Expert 14	11	25	Owner	4.000	Export	
Expert 15	13	27	General Manager	1600	Export	
Expert 16	5	9	Logistics Manager	1600	Export	
Expert 17	18	18	General Manager	1500	Export Local	/
Expert 18	3	7	Operation Manager	4.200	Export Local	/

Expert 19	10	12	Supply Chain Manager	410	Export Local	/

Resource: Compiled by author

After collecting AHP surveys, based on the mathematical explanations, the AHP calculations were completed. Next chapter gives the results of the AHP analysis.

4.4. RELIABILITY AND VALIDITY

Kirk and Miller (1986) stated that qualitative studies are objective once specific components are met. The mentioned components are reliability and validity. In this dissertation, two qualitative methods were applied to analyse qualitative data. Content analysis was employed to analyse the extracted articles, which were the results of the systematic literature review. The extracted articles –in the first systematic literature review- were analysed via content analysis to identify and list of generic and unique stakeholder groups for each type of food supply chains. For the second systematic literature review, content analysis was employed to identify and list logistics-related food loss drivers. Thematic analysis was employed to analyse the interview results. Interviews were conducted with stakeholders to classify and finalize the stakeholder groups for each food supply chain. While analysing the interview results, thematic analysis was employed. Similarly, interviews were conducted with industry experts to classify and list the logistics-related food loss drivers for each food supply chain. Thus, the reliability and validity of each method are going to be discussed separately.

4.4.1. Reliability and validity of the content analysis

In content analysis, reliability can be ensured in three ways, which are stability, reproducibility and accuracy (Krippendorff, 1980). Stability is related to the steadiness of the classifications in time (Weber, 1990). The same content must be coded more than once to the same coder, to ensure the stability. If inconsistencies occur between two coding, the inconsistencies considered a sign of inaccuracy. There could be different reasons for the inconsistencies such as uncertain coding instructions, uncertainty in the text, the coder's viewpoint can be changed, human errors, i.e. writing

wrong numeric code. Since in this form only one person makes the coding, stability is the least favourable reliability type.

Reproducibility is also named as inter-coder reliability. Inter-coder reliability is defined as *“the extent to which independent coders evaluate a characteristic of a message or artefact and reach the same conclusion”* (Lombard et al., 2002). In terms of obtaining quality, measuring inter-coder reliability has importance (Kirk and Miller, 1986). To calculate inter-coder reliability, coding of the dataset must be completed by more than one researcher. While for some of the codes, there is consistency occurs, for some other codes an inconsistency occurs. Inconsistency can be a result of the uncertainty of the coding standards, human error or having different viewpoints while coding the text (Weber, 1990). It is essential that after identifying inconsistencies, coders should reach a consensus by discussing the different coded texts.

Accuracy is defined as *“the extent to which the classification of text corresponds to a standard or norm”* (Weber, 1990). This reliability method is performed when there is a pre-prepared coding scheme is available (Krippendorff, 1980). However, ensuring accuracy is not always possible since research cannot always find a pre-prepared coding scheme.

Moreover, using computer software programs while coding the data is another method of increasing the reliability level (Berg, 2004). Utilizing computer software programs both smooth the coding process and enable conceptualization of the codes. Conceptualized codes can be easily classified mind mapping hierarchically with the help of programs (Franklin et al., 2010). In this thesis, to ensure reliability, NVIVO12 was utilized.

Validity is defined as *“how well an empirical indicator and the conceptual definition of the construct that the indicator is supposed to measure “fit” together”* (Neuman, 2014). According to Weber (1990), in content analysis, two types of validity can occur, which are face validity, and external validity. Face validity is defined as *“a type of measurement validity in which an indicator “makes sense” as a measure of a construct in the judgment of others, especially in the scientific community”* (Neuman, 2014). This type of validity is the easiest validity to obtain (Weber, 1990; Neuman, 2014). Generally, in content analysis, face validity is the easily ensured type (Weber, 1990).

External validity is defined as “*the extent to which the findings of the research can be generalized towards others*” (Andrade, 2018). The use of theory and generalizing the findings to other research context are ways of ensuring external validity. There are two types of external validity occurs, which are ecological validity and population validity (Andrade, 2018). Ecological validity is defined as “*the degree to which results obtained from research or experimentation are representative of conditions in the wider world*” (APA Dictionary of Psychology, 2020a). On the other hand, population validity is defined as “*the degree to which study results from a sample can be generalized to a larger target group of interest (population)*” (APA Dictionary of Psychology, 2020b). Studies conducted on samples, and when the sample represents the overall population validity is achieved (Andrade, 2018). Since the content analysis was applied to identify stakeholder groups and food loss drivers based on the literature review, face validity was achieved.

The results gathered from content analysis, generalized and further analysed for four types of food supply chains. Furthermore, the content analysis was applied to articles which were collected through systematic literature review. Furthermore, during the analysis, not a sample of the extracted analysis but the whole of the population was investigated. So, the found results can be generalized in the literature. Table 18 shows the completed activities to achieve reliability and validity in the content analysis.

Table 18: Activities Conducted to Achieve Reliability and Validity in the Content Analysis

Test	Activities
Reliability	Inter-coder reliability is calculated. Coding performed with NVIVO12. Strict operational procedures were followed.
Face validity	Face validity was achieved
Ecological validity	Results were applied to four types of food supply chains.

Resource: Compiled by author (adapted from Yin, 2009)

4.4.2. Reliability and validity of the thematic analysis

Reliability in qualitative research is defined as *“the extent to which the set of meanings derived from several interpreters are sufficiently congruent”* (LeCompte and Goetz, 1982). In other words, reliability aims to ensure that with utilizing the same data set and inclusion/exclusion criteria and analysis methods, similar results and analysis can be obtained by other researchers. Internal and external reliability must be achieved to ensure reliability in a thematic analysis (LeCompte and Goetz, 1982). Internal reliability is interested in whether establishing the same data set from different researchers by following the same path that the researcher followed during conducting the analysis (LeCompte and Goetz, 1982). On the other hand, external reliability is interested in obtaining the same or similar themes/concepts, that researcher obtained, by another researcher using the same construct (Franklin et al., 2010).

In qualitative studies, reliability can be achieved by a variety of methods. One way of increasing the reliability is by asking similar questions using different words in case of interviewing only once with the interviewee (Newfield et al., 1996). During the interviews, interviewees were asked about various forms of questions. Another method for increasing the reliability in a qualitative study is establishing record procedures (Franklin et al., 2010). To ensure data security in both systematic literature review and content analysis and thematic analysis, strict operational procedures were followed (Yin, 2009). To ensure data security in the interview period, all interviews were tape-recorded and transcribed verbatim. Moreover, using computer software programs while coding the data is another method of increasing the reliability level (Berg, 2004). Utilizing computer software programs both smooth the coding process and enable conceptualization of the codes. Conceptualized codes can be easily classified mind mapping hierarchically with the help of programs (Franklin et al., 2010). In this thesis, to ensure reliability, NVIVO12 was utilized. Calculating inter-coder reliability is another way of ensuring reliability. Inter-coder reliability is defined as *“the extent to which independent coders evaluate a characteristic of a message or artefact and reach the same conclusion”* (Lombard et al., 2002). In terms of obtaining quality, measuring inter-coder reliability has importance (Kirk and Miller, 1986). To calculate inter-coder reliability, coding of the dataset must be completed by more than

one researcher. Thus, two additional researchers coded a sample of the data set to calculate inter-coder reliability. While one of the additional researcher, recoded the data for stakeholder analysis; the other researcher re-coded the data for identifying and classifying LCFLDs. Once the researchers coded the same data differently, researchers came together, discussed the different coded data and reached at the end of the discussion and coded accordingly. In this thesis, while calculating the inter-coder reliability, Perreaults and Leigh's method (1989) was employed. This method offers a direct measurement of reliability. Inter-coder reliability is calculated with Ir , which formula is shown below.

$$Ir = \sqrt{\left\{ \left(\frac{F_o}{N} \right) - \left(\frac{1}{k} \right) \right\} \left[\frac{k}{(k-1)} \right]}$$

In this formula, F_o means the number of coders' agreement, N is the total number of coders' decisions, and k is the number of categories (Perreaults and Leigh, 1989). According to this formulation, an expected inter-coder reliability value should be 0.8 to 1.0 (Perreaults and Leigh, 1989). For each thematic analysis, inter-coder reliability is calculated separately. For the thematic analysis, which was employed to identify and list stakeholder groups, the inter-coder reliability was calculated as 0.83. For the thematic analysis, which was employed to identify and classify logistics-related food loss drivers, the inter-coder reliability was calculated as 0.85. Both of the results were within the expected range.

Validity is defined as *"how well an empirical indicator and the conceptual definition of the construct that the indicator is supposed to measure "fit" together"* (Neuman, 2014). Reliability is a requirement while ensuring validity (Franklin et al., 2010), and it is more challenging to achieve validity compared to reliability (Neuman, 2014). Although reliability is a necessity for ensuring validity, it does not ensure to obtain validity (Neuman, 2014). Miles and Huberman (1994) mentioned validating themes in both early and late stages of the analysis is fundamental. Alhojailan (2012) stated that during identifying and evaluating the themes, a second researcher should involve and provide feedback to the main researcher. Internal validity is defined as *"the extent to which the observed results represent the truth in the population we are studying and thus, not due to methodological errors"* (Patino and Ferreira, 2018).

Construct validity is defined as “*a type of measurement validity that uses multiple indicators and has two subtypes: how well the indicators of one construct converge or how well the indicators of different constructs diverge*” (Neuman, 2014). External validity refers to “*the extent to which the results of a study are generalizable to patients in our daily practice, especially for the population that the sample is thought to represent*” (Patino and Ferreira, 2018). Table 19 shows the completed activities to achieve reliability and validity in the thematic analysis.

Table 19: Activities Conducted to Achieve Reliability and Validity in the Thematic Analysis

Test	Activity
Reliability	Similar questions (with different wordings) were utilized while asking questions. Strict operational procedures were followed. All interviews were tape-recorded and transcribed verbatim. Coding performed with NVIVO12. Inter-coder reliability is calculated.
Internal validity	More than one type of food supply chains was selected. Another researcher evaluated identified factors (themes) and sub-themes.
Construct validity	Interviews were completed with different stakeholders to control and confirm collected data. Multiple data and documents were examined.
External validity	Strict protocol rules were followed. Obtained results from the thematic analysis were employed four different food supply chains.

Resource: Compiled by author (adapted from Yin, 2009)

CHAPTER V

ANALYSIS AND RESULTS

5.1. FINDINGS OF STAKEHOLDER ANALYSIS

5.1.1. Results of Literature Review

As it is explained the chapter four, the first stage of the identification and classification of the CUMSs is developing the purpose of the stakeholder analysis. The purpose of the stakeholder analysis is to identify which stakeholders have more salience while tacking with the food loss on the food supply chains. The second step is to conduct the analysis to identify possible food supply chain, stakeholders. Based on the explained literature review research process, the literature review was conducted, and the literature review consisted of 25 articles. Table 20 lists the food supply chain stakeholders that are identified via the literature review.

Food supply chains are considered as complicated because of outspread systems to the entire world, and a vast number of stakeholders participate in these complex systems. Moreover, the literature review revealed that there is no agreement on the definition and the word preference of some stakeholder groups.

Similar to other supply chains, food supply chains also begin with suppliers. Food supply chain suppliers are entities that provide raw materials to farmers, including feeds, pesticides, medicines, farming equipment and agricultural tools. Six of the examined studies also identified and utilised suppliers as it was explained in the definition. However, three of the studies focused one aspect of the supplier and solely employed this type of supplier in their study which was feed supplier (Erdem et al., 2012; Schiefer and Deiters, 2013).

In the literature, researchers used different stakeholder names for explaining people/organizations which have the same tasks and likewise, researchers used the same name for explaining people/organizations which have different tasks. Primary producers are people or entities which conduct agricultural activities, aquaculture, fisheries and similar processes resulting in raw food materials. At the same time, farmers are people or entities which employ in agriculture, raising living organisms

for food or raw food material, and cultivates farmland to grow food. Although primary producing activities encompass farming activities, it has been observed that in the literature primary producing and farming used for the same purpose. Rantavaara et al., (2005), Van der Vorst et al. (2005), Schiefer and Deiters (2013), Parwez (2016), Arivazhagan et al. (2017) utilized farmer; while Halloran et al. (2014), LeBlanc et al. (2015) employed primary producer to explain, identify and analyse the same stakeholder. Moreover, studies used farmer and producer interchangeably such as (Jaffee et al., 2010; Leat et al., 2011; Erdem et al., 2012; Beretta et al., 2013; Kumar et al., 2013; Verhofstadt and Maertens, 2013; Tsolakis et al., 2014; Yan and Xu, 2016; Gjokaj et al., 2017).



Table 20: List of Identified Stakeholders

Stakeholder	Definition	Reference
Supplier	People or entities provide raw materials to farmers. These materials are included feeds, pesticides, medicines, farming equipment and agricultural tools.	Jaffee et al., 2010; Kumar and Nigmatullin, 2011; Kumar et al., 2013; Tsolakis et al., 2014; Busse et al., 2017; Ocampo et al., 2018
Feed supplier	People or entities which provide feeds for the livestock and seeds for the farmlands.	Erdem et al., 2012; Schiefer and Deiters, 2013
Producer (primary producer)	People or entities which conduct agricultural activities, aquaculture, fisheries and similar processes resulting in raw food materials	Jaffee et al., 2010; Leat et al., 2011; Erdem et al., 2012; Beretta et al., 2013; Chabada et al., 2013; Kumar et al., 2013; Verhofstadt and Maertens, 2013; Halloran et al., 2014; Tsolakis et al., 2014; LeBlanc et al., 2015; Yan and Xu, 2016; Canali et al., 2017; Gjokaj et al., 2017
Farmer	People or entities which employ in agriculture, raising living organisms for food or raw food material, and cultivates farmland to grow food	Rantavaara et al. 2005; Van der Vorst, 2005; Leat et al., 2011; Erdem et al., 2012; Beretta et al., 2013; Chabada et al., 2013; Kumar et al., 2013; Schiefer and Deiters, 2013; Verhofstadt and Maertens, 2013; Halloran et al., 2014; Tsolakis et al., 2014; Parwez, 2016; Yan and Xu, 2016; Arivazhagan et al., 2017; Gjokaj et al., 2017; Diaz-Ruiz et al., 2018
Agricultural cooperative (Farm association)	An organization where farmers combine their resources for a certain type of activities	Leat et al., 2011; Diaz-Ruiz et al., 2018
Trader – import (raw food material)	People or entities who sell raw food materials for either direct selling purpose or further processing in abroad	Verhofstadt and Maertens, 2013; Arivazhagan et al., 2017; Gjokaj et al., 2017
Trader – export (raw food material)	People or entities who bring raw food materials to the country for either direct selling purpose or further processing	Jaffee et al., 2010; Verhofstadt and Maertens, 2013
Food processor (Primary processor / First level manufacturer)	Entities which transforms raw food materials to food.	Rantavaara et al. 2005; Van der Vorst, 2005; Jaffee et al., 2010; Leat et al., 2011; Erdem et al., 2012; Rediers et al., 2012; Schiefer and Deiters, 2013; Verhofstadt and Maertens, 2013; Halloran et al., 2014; Tsolakis et al., 2014; LeBlanc et al.,

		2015; Parwez, 2016; Yan and Xu, 2016; Arivazhagan et al., 2017; Busse et al., 2017; Canali et al., 2017; Gjokaj et al., 2017
Food manufacturer (Secondary processor / Second level manufacturer)	Entities which takes food from the first level manufacturer and turn into new products	Sodhi and Tang, 2008; Kumar and Nigmatullin, 2011; Schiefer and Deiters, 2013; Bourlakis et al., 2014; Tsolakis et al., 2014; Canali et al., 2017
Slaughterhouse	The facility where livestock are slaughtered, to provide food for people	Beretta et al., 2013; Schiefer and Deiters, 2013
Packaging company	A company that produces packaging material to package processed or manufactured product to eliminate contamination or to increase the food's shelf life.	Kumar et al., 2013; Yan and Xu, 2016; Canali et al., 2017
Distributor	Entities which deliver food to retailers as well as wholesalers	Van der Vorst, 2005; Kumar and Nigmatullin, 2011; Rediers et al., 2012; Kumar et al., 2013; LeBlanc et al., 2015; Yan and Xu, 2016; Diaz-Ruiz et al., 2018
Wholesaler	Entities which sell food products to retailers, supermarkets, local markets, and convenience stores.	Matopoulos et al., 2007; Erdem et al., 2012; Beretta et al., 2013; Chabada et al., 2013; Kumar et al., 2013; Bourlakis et al., 2014; Halloran et al., 2014; Tsolakis et al., 2014; Parwez, 2016; Canali et al., 2017; Gjokaj et al., 2017; Diaz-Ruiz et al., 2018
Retailer	Entities sell food to people in small quantities for use or consumption.	Rantavaara et al. 2005; Van der Vorst, 2005; Jaffee et al., 2010; Leat et al., 2011; Kumar and Nigmatullin, 2011; Rediers et al., 2012; Beretta et al., 2013; Chabada et al., 2013; Kumar et al., 2013; Schiefer and Deiters, 2013; Verhofstadt and Maertens, 2013; Bourlakis et al., 2014; Halloran et al., 2014; Tsolakis et al., 2014; LeBlanc et al., 2015; Arivazhagan et al., 2017; Busse et al., 2017; Canali et al., 2017; Gjokaj et al., 2017; Diaz-Ruiz et al., 2018

Supermarket	A self-service shop, which offers a wide variety of food and beverages.	Rantavaara et al. 2005; Verhofstadt and Maertens, 2013
Local market	A small business which sells everyday items. A local market can be a branch of a retailer or a person's own store.	Rantavaara et al. 2005; Verhofstadt and Maertens, 2013; Gjokaj et al., 2017; Diaz-Ruiz et al., 2018
Convenience store	Small business, which sells everyday items such as coffee, groceries, snack food. Generally, convenience stores belong to individuals.	Gjokaj et al., 2017; Kumar et al., 2013
Logistics service provider	Entities which transport raw food materials and finished food materials between food supply chain actors at a national and international level.	Rantavaara et al. 2005; Matopoulos et al., 2007; Erdem et al., 2012; Kumar et al., 2013; LeBlanc et al., 2015; Yan and Xu, 2016; Canali et al., 2017; Ocampo et al. 2018
Food service	Entities, which prepare a meal for eating outside.	Rantavaara et al. 2005; Matopoulos et al., 2007; Rediers et al., 2012; Schiefer and Deiters, 2013; Halloran et al., 2014; Canali et al., 2017
Customer	A person, who buys food from a retailer, supermarket, local market or convenience market.	Rantavaara et al. 2005; Matopoulos et al., 2007; Sodhi and Tang, 2008; Leat et al., 2011; Kumar and Nigmatullin, 2011; Erdem et al., 2012; Rediers et al., 2012; Beretta et al., 2013; Halloran et al., 2014; Tsolakis et al., 2014; Arivazhagan et al., 2017; Busse et al., 2017; Canali et al., 2017; Diaz-Ruiz et al., 2018; Ocampo et al., 2018
Food bank	Non-profit, charitable entities that distribute food to people who have difficulty purchasing enough to avoid hunger	Canali et al., 2017; Diaz-Ruiz et al., 2018
Research centre & institute (university)	Establishment founded for doing research	Matopoulos et al., 2007; Sodhi and Tang, 2008; Diaz-Ruiz et al., 2018
Financial institution (Banking institutions)	Entities that provide financial services	Busse et al., 2017; Ocampo et al., 2018
Competitor	Entities that are rival against another	Busse et al., 2017; Ocampo et al., 2018
Employee	A person employed for wage or salary	Busse et al., 2017; Ocampo et al., 2018
Society	The aggregate of people living in a more or less ordered community	Ocampo et al., 2018

Government	The group of people with authority to govern a country or state	Van der Vorst, 2005; Kumar et al., 2013; Busse et al., 2017; Ocampo et al., 2018
Policy maker and regulator	An organization, which is responsible for formulation policies	Sodhi and Tang, 2008; Ocampo et al., 2018
Union	A society or association formed by people with a common interest or purpose	Busse et al., 2017; Ocampo et al., 2018

Resource: Compiled by author

Based on the literature review, another identified stakeholder group is agricultural cooperatives. An agricultural cooperative is defined as “*an organization where farmers combine their resources for a certain type of activities*”, and this stakeholder group appeared in two studies. Another stakeholder group is traders who buy raw food materials from the origin country and sell it to abroad as the final product or for further processing. Traders can also import raw food material with the same purpose of export traders. Both import and export traders showed up in three studies.

The other controversy stakeholder groups are food processors and manufacturers. Food processors transform raw food materials into food. Processing can also be referred to as primary processing or primary manufacturing. Food manufacturers take processed food from the first level manufacturer, use them and turn into new products. For example, a food processor takes freshly harvested tomatoes from the field and process them and turn them to dried tomato. Food manufacturer procures the dried tomato and uses them to manufacture pizza. Although the tasks and activities of food producer and food manufacturers are different, most of the studies ignored this difference and used the name of the stakeholders interchangeably. In their studies, Sodhi and Tang (2008), Kumar and Nigmatullin (2011) and Bourlaikis et al. (2014) used food manufacturer; while researchers such as Leat et al. (2011), Kumar et al. (2013), Parwez (2016) and Diaz-Ruez et al. (2018) used food producer. Tsolakis et al. (2014) used food producer and food manufacturer simultaneously in their studies.

Another stakeholder group is slaughterhouses, which is defined as a facility where livestock are slaughtered, to provide food for people. This stakeholder group has been included in the studies which deal with meat and poultry supply chains (Beretta et al., 2013; Schiefer and Deiters, 2013). Based on the literature review, another identified stakeholder group is packaging companies. These companies produce packaging material to package processed or manufactured product to eliminate the contamination or to increase the food's shelf life. Kumar et al. (2013), Yan and Xu et al. (2016) and Canali et al. (2017) employed a packaging company as a stakeholder in their studies.

Literature review revealed that studies used different type of stakeholders while explaining/investigating the distribution of foods such as distributors, wholesalers, retailers, supermarkets, local stores and convenience stores. Distributors deliver food

to retailers and wholesalers. Distributors can sell a wide range of products or be specialized in a specific type of foods. Distributors purchase foods in bulk and sell foods in bulk. Distributors have a distribution network and actively participate in transportation. The ownership of the products does not have to belong to distributors. Seven of the examined articles included distributors in their analysis. A wholesaler sells a wide range of food products (or a certain type of food products) to other businesses such as retailers, supermarkets, local stores and convenience stores. The wholesalers get the ownership of the products and put a margin on the product and sell after that. Wholesalers make bulk purchasing and sell in either bulk form or smaller quantities. Wholesalers store the products in their warehouses or storage units. The distribution of the products can either be completed from the wholesalers or the customers. Twelve of the selected articles employed wholesalers in their analysis. Retailers sell food in small quantities for use or consumption. Twenty of the examined articles employed retailers in their studies. Supermarkets are self-service shops which offer a wide variety of food and beverages to customers. Three studies utilized supermarkets in their researches. Local markets are small businesses which sell everyday items. These markets can be a branch of a retailer or a person's own store. Convenience stores are another stakeholder group, which are employed in selected articles, and defined as small businesses which sell everyday items, and generally belong to an individual.

According to the literature review, one of the key stakeholder group is logistics service providers. This stakeholder group transports raw food materials and finished food materials between food supply chain actors at a national and international level. Eight of the examined articles have employed this stakeholder group in their researches.

According to the literature review, the main stakeholder groups at the consumption stage is food services and customers. Food services prepare a meal for eating outside, including restaurants, cafes and cafeterias. Customer, who buys food from a retailer, supermarket, local market or convenience market, is an essential stakeholder in the food supply chain and fifteen of the selected articles utilized customer in their studies.

Food banks are recently joined food supply chain stakeholder considering the history of the food supply chain. The first food bank opened in 1967 in the US (Food Poverty, 2020). The food bank is defined as “*non-profit, charitable entities that distribute food to people who have difficulty purchasing enough to avoid hunger*” (Food Poverty, 2020), which is defined as a stakeholder group and investigated in studies. Research centres and institutions are also considered as a food stakeholder group and employed in food supply chain studies. Likewise, research centres and institutions, financial institutions were also considered as food supply chain stakeholders and utilized in the researches.

Only two studies employed competitors and employees in studies as stakeholder groups (Busse et al., 2017; Ocampo et al. 2018). In addition to stakeholder groups that are explained above, there are other stakeholder groups such as society, government, policy maker and regulator and unions, who were also employed in different researches.

Although FSC stakeholders are listed on the Table 20, due to the scope of this thesis, which was determined according to food loss definition, some of the stakeholders eliminated before the interview process. According to FAO (2019a) food loss definition, food loss occurs in the FSC excluding retailers, service providers and consumers. Thus, these downstream stakeholders were removed from the stakeholder list. In regards to FAO (2019a) definition, following stakeholders were removed; retailer, supermarket, local market, convenience store, food service, customer and food bank. Table 21 shows the updated version of the stakeholder leads who might deal with food loss.

Table 21: Updated Stakeholder List According to Scope of the Study

Stakeholder
Supplier
Feed supplier
Producer (primary producer)
Farmer
Agricultural cooperative (Farm association)

Trader – import (raw food material)
Trader – export (raw food material)
Food processor (Primary processor / First level manufacturer)
Food manufacturer (Secondary processor / Second level manufacturer)
Slaughterhouse
Packaging company
Distributor
Wholesaler
Logistics service provider
Research center & institute (university)
Financial institution (Banking institutions)
Competitor
Employee
Society
Government
Policy maker and regulator
Union

Resource: Compiled by author

After finalizing the stakeholder list, the next stage was conducting interviews with industry members to both validate the literature review and ask them to complete stakeholder attribution chart. Next section gives the literature review results, demonstrates the actors in each food supply chains and classifies the CUMSs, according to Mitchell et al. (1997)'s analytical categorization.

5.1.2. Results of Interview Review

Reviewed articles examined foreign food supply chains, yet the purpose of these studies were different. None of them tried to identify which stakeholders have more salience while tackling the food loss on the supply chains. Thus, to understand

this, twenty four interviews were conducted with experts from the different food supply chains. In the next section, identified stakeholders, Venn diagram, which shows the salience of the stakeholders and the framework of their supply chain is going to be provided, respectively.

5.1.2.1. Identification and salience of stakeholders in fats and oil supply chain

To identify CUMSs in the fats and oil supply chain, nine interviews were conducted with participants who have experience in related areas of fats and oil supply chain. Two interviews were conducted with farmers who grow oilseed and olive. Two interviews were conducted with oil refineries. One interview was conducted with a retailer; on the other hand, another interview was conducted with a wholesaler. Besides, two interviews were conducted with transportation executives who transport raw and finished products. One interview was conducted with an executive from the packaging industry, and one interview was conducted with a food security certificate inspector.

Based on the interview results, the name of some stakeholder groups was combined, renamed, added or removed from the initial list, which was shown in Table 21. Conducted interviews with experts revealed that people who grow crops are named as farmers. Thus, in the analysis, we employed “farmer” instead of “producer”. Also, results of interviews revealed that in a fats and oil supply chain, primary processors are named as “refinery”. Thus, we renamed the primary processor as “fats and oil refinery”. Interviews also revealed that in fats and oil supply chain, two stakeholders actively participate who are raw oil wholesalers and oil extraction facilities. Thus, we also added these two stakeholders to our analysis. Table 22 shows some of the quotations that we used in thematic analysis while identifying stakeholder groups.

Table 22: Quotations from Fats and Oil Industry Experts

Expert	Comment about a stakeholder group	Quotation
Food security certificate inspector	Producers and farmers	<i>People who are responsible for growing seeds and harvesting crops are farmers.</i>
Farmer 2	Producers and farmers	<i>In one part of the land, I grow up olive for the purpose of producing oil, and I proudly consider myself a farmer. My father was a farmer and I am a farmer.</i>
O2	Fats and oil refinery	<i>The raw oil is transported to our refinery facilities via tankers, and in our facilities, we refine and process this raw oil and get the finished products.</i>
Farmer 1	Oil extraction facilities	<i>To acquire olive oil, olives need to be broken. Most of the farmers around here do not have that equipment, thus when we harvest the olives, we carry the freshly harvested crops to olive oil extraction facilities, and they work with commissions. Thus, they get a certain percentage of the overall extracted raw olive oil.</i>
O1	Raw oil wholesaler	<i>We do not buy the raw oil directly from the farmer. Because we need big amounts to start the refinery processing. Thus, we prefer to work with raw olive oil wholesalers. They collect the raw olive oil and send us in bulk.</i>

Resource: Compiled by author

Moreover, the interviews revealed that not all of the listed stakeholder groups directly deal with food loss in their facilities. Thus, before determining the salience of stakeholders, stakeholders who do not deal with food loss were excluded from the list. The excluded stakeholder groups are suppliers, agricultural cooperatives, financial institutions, policymakers and regulators, unions, packaging companies, research centres and institutes, societies, and competitors. Table 23 provides some quotations from the experts who mention about the exclusion of some stakeholder groups.

Table 23: Quotations from Fats and Oil Industry Experts

Expert	Name of the stakeholder	Quotation
Farmer 2	Supplier	<i>My seed and pesticide supplier is one of the big international seed suppliers in the world. They do not deal with any harvested crops, and they don't deal with loss.</i>
Farmer 2	Agricultural cooperative	<i>I'm a member of a cooperative, and it supports all members in certain activities, yet cooperative is not responsible for the amount of loss that we deal with.</i>
Farmer 1	Financial institution	<i>Banks lend us money. They do not involve the actual loss.</i>
Food security certificate inspector	Policy makers and regulator	<i>Actually, regulators are closely related to the amount of lost food on the supply chain and try to identify the solutions to overcome the loss. But they are not part of the problem.</i>
O2	Union	<i>In our country, unions mostly deal with better or equal working conditions for workers. Their interest is not food loss.</i>
P1	Packaging company	<i>We supply packaging materials, and we only produce those materials and transport them to our customers' facilities. We do not deal with any food in our facilities.</i>
Food security certificate inspector	The research centre and institution	<i>Research centres can be part of the solution. They do not cause food loss.</i>
R4	Society	<i>Society closely monitors the situation about food loss because in our society food is considered as sacred. However, they do not take an active part in loss which is occurred in facilities.</i>
O1	Competitors	<i>Of course, we have competitors, and I am sure that they also deal with some amount of food loss, yet they do not relate to in our food loss.</i>

Resource: Compiled by author

According to results of thematic analysis, farmers, oil extraction facilities, raw oil wholesalers, traders (import), oil refinery, traders (export), wholesalers, distributors, food manufacturers, and logistics service providers were identified as the critical upstream and midstream stakeholders for fats and oil supply chain. After completing the identification of CUMSs, the next stage is classification of the CUMSs. For this purpose, the method which was explained in the methodology section, was employed. After the analysis which is conducted according to Tsoufas et al. (2019)'s protocol, the classification of the CUMSs is shown in the Table 24.

Table 24: Classification of CUMSs for Fats and Oil Supply Chain

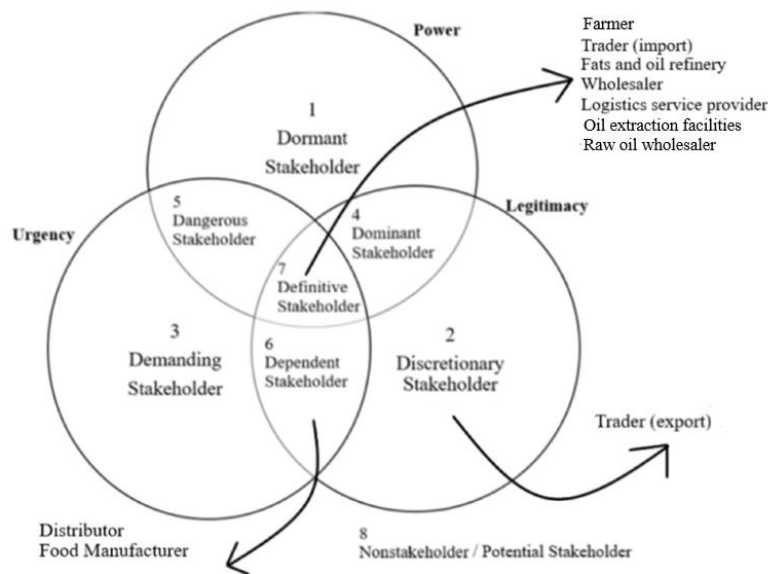
Stakeholder	Legitimacy	Power	Urgency	Stakeholder Type	Stakeholder Salience
Farmers	High	Medium	Medium	<i>Definitive</i>	<i>High</i>
Oil extraction facility	High	Low	Low	<i>Definitive</i>	<i>High</i>
Raw oil wholesaler	Medium	Low	Low	<i>Definitive</i>	<i>High</i>
Trader (import)	Medium	Medium	High	<i>Definitive</i>	<i>High</i>
Fats and oil refinery	Very high	Very high	Very high	<i>Definitive</i>	<i>High</i>
Trader (export)	Medium	Absent	Absent	<i>Discretionary</i>	<i>Latent</i>
Wholesaler	Medium	Low	High	<i>Definitive</i>	<i>High</i>
Distributor	High	Absent	High	<i>Dependent</i>	<i>Expectant</i>
Food manufacturer	High	Absent	High	<i>Dependent</i>	<i>Expectant</i>
Logistics service provider	Medium	Medium	Medium	<i>Definitive</i>	<i>High</i>

Resource: Compiled by author

Analysis results reveal that seven out of ten stakeholder groups are classified as definitive stakeholders meaning that these stakeholder groups have all three attributes. Definitive stakeholders are farmers, oil extraction facilities, raw oil wholesalers, traders who import raw materials, refineries, wholesaler, and logistics service providers. According to Mitchell et al. (1997), definitive stakeholders have

high salience. Based on the results, distributor and food manufacturers are classified as dependent stakeholders. Dependent stakeholders hold two attributes which are legitimacy and urgency, and they are considered as expectant in terms of salience (Mitchell et al., 1997). Traders who export finished products are classified as discretionary stakeholders. Discretionary stakeholders hold only one attribute, which is legitimacy and considered as latent in terms of salience (Mitchell et al., 1997). Figure 20 shows the CUMSs on Mitchell's Venn diagram.

Figure 20: Classification of CUMSs on Venn diagram for Fats and Oil Supply Chain



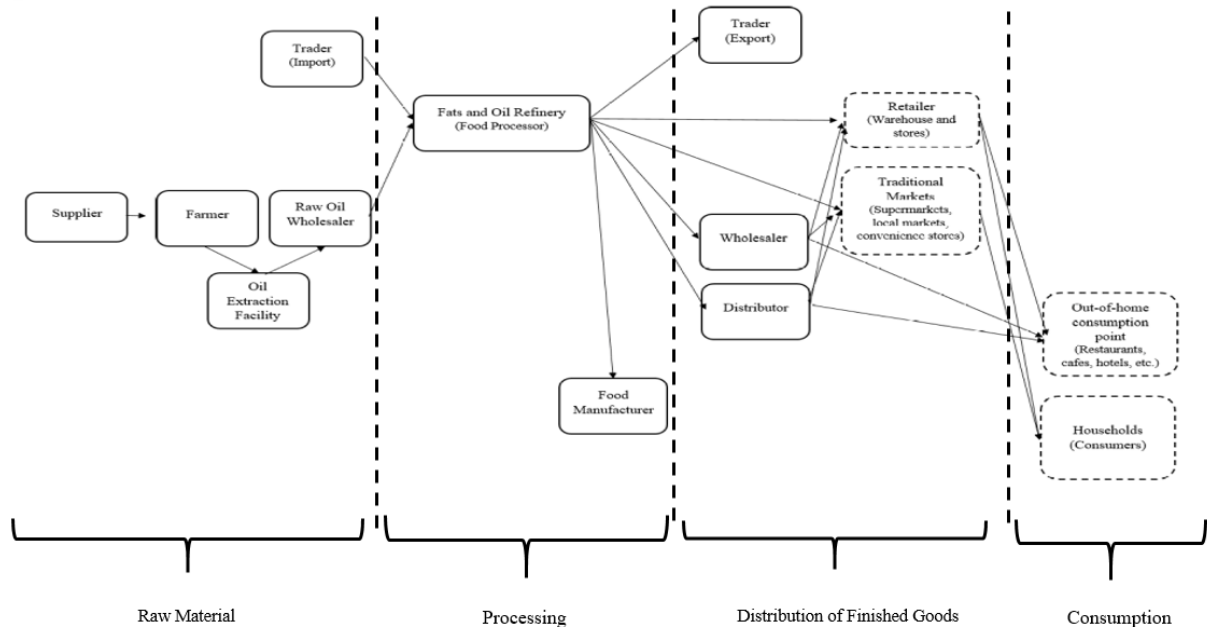
Resource: Compiled by author

Based on the interview results, Figure 21 shows the generic fats and oil supply chain framework in Turkey. To ensure holistic viewpoint, the created food supply chain framework includes all supply chain stakeholders. The CUMSs were provided in strict line rectangles; while rest of the stakeholders were provided in dashed line rectangles on the figure.

A typical fats and oil supply chain starts with first-tier suppliers. These suppliers provide seeds, pesticides and farming equipment to farmers. After the farmer grows the seeds and harvests the crops, farmers send crops to olive oil extraction facilities. At these facilities, seeds turn to raw olive oil with pressing and or extraction.

The extracted olive oils are sold to raw olive oil wholesalers, and the raw oil wholesalers sell the raw oils to fats and oil refinery or in other words, food processors. At the same time, refineries are fed by the traders because some raw oils come from abroad. Raw oils are processed and transformed into finished products at the refineries.

Figure 21: Generic Fats and Oil Supply Chain



Resource: Compiled by author

A fats and oil refinery supply finished products to different stakeholders, which are export traders, wholesalers, distributors and food manufacturers. Instead of small packages, the finished product is sent in bulk during the export. The finished product of processors can be used as raw material at food manufacturers such as ready-to-eat food manufacturers. Thus, refineries also supply finished products to food manufacturers.

In terms of the distribution of the food to final consumers, fats and oil processors (refinery) sell their products with three different methods, which are direct selling, using wholesalers or using distributors. In direct selling, processors directly sell their products to retailers, traditional markets and out-of-home consumption points. Another distribution channel for processors is wholesalers. Wholesalers get the ownership of the products and sell the finished products to out-of-home consumption points, retailers, and traditional markets with adding a profit margin. Processors

receive their money when they sell the finished products to the wholesaler. Distributors are another stakeholder in the distribution channel. Distributors can be owned by the processors or joint-company of the processors. In Turkey, food processors use more than one channel during the distribution. While distributing the finished products to the retailer, processors prefer to distribute themselves. Besides, processors use distributors or wholesalers while distributing the finished products to out-of-home consumption points and traditional markets.

Households and out-of-home consumption points generate the consumption stage of the fats and oil supply chain. While out-of-home consumption points are fed by wholesalers, distributors, retailers and traditional markets; households are fed by traditional markets and retailers.

5.1.2.2. Identification and salience of stakeholders in milk and dairy product supply chain

To identify and classify the CUMSs in milk and dairy product supply chain, eight interviews were conducted with different experts from the milk and dairy products industry. Two interviews were conducted with experts from the milk processing industry. One interview was conducted with a retailer while another interview was conducted with a wholesaler. In addition, Two interviews were conducted by transportation executives who transport raw milk and finished milk and dairy products. One interview was conducted with an executive from the packaging industry, and another interview was conducted with food security certificate inspector.

Based on the interview results, the name of some stakeholder groups was combined, renamed, added or removed from the initial list, which was shown in Table 21. Conducted interviews with experts unveiled that people who raise livestock are named as “dairy farmer”, and instead of using farmer and or producer, we used dairy farmer during the research. Besides, primary processors are named as “milk producer”. Analysis results ascertained that one stakeholder group actively take part in the supply chain. Thus, we also added “milk collection points” to list. Also, interviews showed that in dairy supply chains, stakeholders use agents instead of distributors. Table 25 shows some of the quotations that industry experts mentioned during the interviews.

Table 25: Quotations from the Milk and Dairy Industry Experts

Expert	Comment about a stakeholder group	Quotation
D4	Dairy farmer	<i>Dairy farmers are responsible for milking livestock.</i>
D3	Milk collection point	<i>We have a big integrated production plant and to start the production, we need 60,000 tons of raw milk in our raw milk tanks. To ensure that we can produce daily, we make a contract with several milk collection point.</i>
D4	Milk collection point	<i>One of the most important suppliers of our company is milk collection firms. They supply us a certain amount of milk each day.</i>
D3	Milk processor	<i>We are milk processors, and we pasteurize raw milk and produce a wide variety of products.</i>
D4	Agent	<i>We have our own distribution agent. We are the parent company, and they are responsible for our entire distribution network across Turkey.</i>

Resource: Compiled by author

Moreover, the interviews revealed that not all of the listed stakeholder groups directly deal with food loss in their facilities. Thus, before determining the salience of stakeholders, stakeholders who do not deal with food loss were excluded from the list. The excluded stakeholder groups are suppliers, milk producers association (agricultural cooperatives), financial institutions, policymakers and regulators, unions, packaging companies, research centres and institutes, societies, and competitors. Table 26 provides some quotations from the experts who mention about the exclusion of some stakeholder groups.

Table 26: Quotations from Milk and Dairy Industry Experts

Expert	Name of the stakeholder	Quotation
D4	Supplier	<i>Dairy farmers' suppliers do not take part in any food production activity since they just supply medicine and equipment.</i>
D3	Milk producers association	<i>This association mainly supports small producers in terms of marketing activities. In addition, they support dairy farmers to obtain certain quality certificates.</i>
D4	Financial institution	<i>Financial institutions loan money to us when we need them. I think they are not really interested in what we are doing as long as we pay our debt on time.</i>
Food security certificate inspector	Policy makers and regulator	<i>Actually, regulators are closely related to the amount of lost food on the supply chain and try to identify the solutions to overcome the loss. But they are not part of the problem.</i>
D3	Union	<i>In our industry, unions are more related to workers right.</i>
P1	Packaging company	<i>We supply packaging materials, and we only produce those materials and transport them to our customers' facilities. We do not deal with any food in our facilities.</i>
Food security certificate inspector	The research centre and institution	<i>Research centres can be part of the solution. They do not cause food loss.</i>
R4	Society	<i>Society closely monitors the situation about food loss because in our society food is considered as sacred. However, they do not take an active part in loss which is occurred in facilities.</i>
R4	Food bank	<i>Food banks are definitely an important stakeholder in the food</i>

supply chain since they help us in terms of diminishing the amount of food loss.

D3 Competitors

Of course, we have competitors, and probably they also deal with a loss for a certain amount, but we can't know exactly.

Resource: Compiled by author

According to results of thematic analysis, dairy farmers, milk collection points, milk processors, traders (export), wholesalers, agents, food manufacturers and logistics service providers were identified as the critical upstream and midstream stakeholders for milk and dairy food supply chain. After completing the identification of CUMSs, the next stage is classification of the CUMSs. For this purpose, the method which was explained in the methodology section, was employed. After the analysis which is conducted according to Tsoulfas et al. (2019)'s protocol, the classification of the CUMSs is shown in the Table 27.

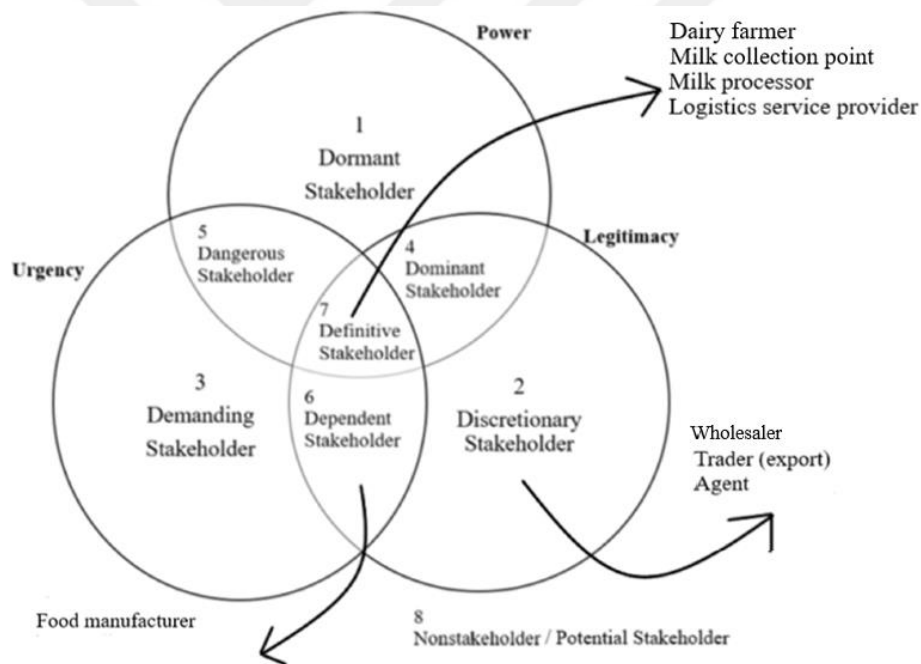
Table 27: Classification of CUMSs for Milk and Dairy Products Supply Chain

Stakeholder	Legitimacy	Power	Urgency	Stakeholder Type	Stakeholder Salience
Dairy farmers	High	Very high	Medium	<i>Definitive</i>	<i>High</i>
Milk collection point	Medium	High	Medium	<i>Definitive</i>	<i>High</i>
Milk processor	Very high	Very high	Very high	<i>Definitive</i>	<i>High</i>
Trader (export)	High	Absent	Absent	<i>Discretionary</i>	<i>Latent</i>
Wholesaler	High	Absent	Absent	<i>Discretionary</i>	<i>Latent</i>
Agent	Very high	Absent	Absent	<i>Discretionary</i>	<i>Latent</i>
Food manufacturer	High	Absent	High	<i>Dependent</i>	<i>Expectant</i>
Logistics service provider	High	High	High	<i>Definitive</i>	<i>High</i>

Resource: Compiled by author

Analysis results reveal that four out of eight stakeholder groups are classified as definitive stakeholders meaning that these stakeholder groups have all three attributes. Dairy farmers, milk collection points, milk processors and logistics service providers are classified as definitive stakeholders. According to stakeholder analysis, and food manufacturer are classified as dependent stakeholders. Dependent stakeholders have the two attributes, which are power and legitimacy, and stakeholders who have two attributes are classified as expectant stakeholders (Mitchell et al., 1997). Traders who export finished products, wholesalers, agents are classified as latent stakeholders, meaning that they only have legitimacy attribute and named as discretionary stakeholders. Figure 22 shows the CUMSs on Mitchell's Venn diagram.

Figure 22: Classification of CUMSs on Venn diagram for Milk and Dairy Products Supply Chain



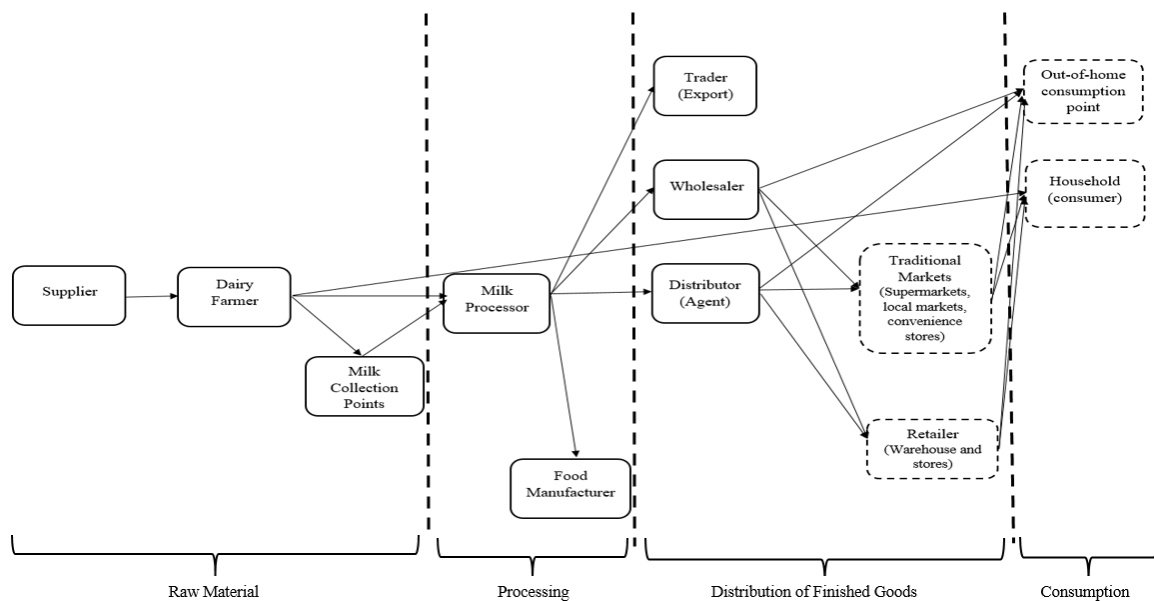
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Based on the interview results, Figure 23 shows the generic milk and dairy food supply chain framework in Turkey. To ensure holistic viewpoint, the created food supply chain framework includes all supply chain stakeholders. The CUMSs were provided in strict line rectangles; while rest of the stakeholders were provided in dashed line rectangles on the figure.

The dairy food supply chain starts with suppliers, who supply equipment, animal feed and vitamins and medicines for the dairy farmers. Dairy farmers feed and raise livestock which is capable of milk. Farmers collect raw milk daily basis, and the collected raw milk needs to be processed within 48 hours. Thus, the transportation of raw milk needs to be completed quickly via refrigerated vehicles. Dairy farmers supply three stakeholders who are milk collection points, milk processors and households. Food processors prefer to procure raw material from the milk collection points. However, some of them may also prefer to procure raw materials from dairy farmers. In addition, buying raw milk from dairy farmers and boiling and using it for drinking and making yoghurt is also a common approach which is adopted by households in Turkey. Each year, 11 percent of the raw milk directly sell to consumers in Turkey (TAGEM, 2018). Thus, dairy farmers can sell their raw milk to directly households.

All collected raw milk at the milk collection points will be sent to milk producers. Milk producers prefer to purchase raw milk from milk collection points because it is convenient. At milk processors, raw milk is pasteurized, homogenized, and fortified. After these processes, based on the demand, processed milk is processed to cheese, yoghurt and other milk and dairy products. In Turkey, some milk cooperatives (such as Tire Sut) act as milk processors. Thus, during the analysis, these type of milk cooperatives are also considered as milk processor.

Figure 23: Generic Milk and Dairy Products Supply Chain



Resource: Compiled by author

A milk processor supplies different stakeholders such as traders who export, food manufacturers, distributors, wholesalers and retailers. Since the finished product can be used as raw material at food manufacturers such as ready-to-eat food manufacturers, milk producers supply food manufacturers. The export of milk and dairy products is enabled via the trader. Moreover, milk processors use direct selling channel for retailers. Wholesalers can also take part in the milk and dairy product distribution channel. Wholesalers can supply milk and dairy products to retailers, traditional markets, and out-of-home consumption points. However, most of the distribution channel of the milk and dairy products are managed by the distributors (agents) in Turkey. In general, food processors are a parent company of an agent (distributor) and processors sell finished products via the agent's distribution channel. Agents have a strong and extensive distribution network; thus, they are able to distribute the finished products to traditional markets, retailers, out-of-home consumption points.

Households and out-of-home consumption points generate the consumption stage of the dairy supply chain. While out-of-home consumption points are fed by a wholesaler, distributor, retailer and traditional markets; households are fed by traditional markets and retailers.

5.1.2.3. Identification and salience of stakeholders in meat and poultry supply chain

To identify and classify the CUMSs in the meat and poultry supply chain, nine interviews were conducted with different experts from the meat and poultry industry. One interview was conducted with an executive from meat and meat industry; while two interviews were conducted with executives from the poultry industry. In addition, one interview was conducted with a retailer while another interview was conducted with a wholesaler. Also, two interviews were conducted by transportation executives who transport raw and finished meat and poultry products. One interview was

conducted with an executive from the packaging industry, and another interview was conducted with food security certificate inspector.

Based on the interview results, the name of some stakeholder groups was combined, renamed, added or removed from the initial list, which was shown in Table 21. Conducted interviews with experts revealed that cattle are raised in the animal farm; while the chicken is raised in the coop. Thus, we renamed the farmer stakeholder to animal farm/coop. In meat and poultry supply chain, slaughterhouse, which is also identified in the initial list (Table 21), acts as a food processor. Similar to what I have observed in the dairy supply chain, food manufacturers prefer to work with agents in the meat and poultry supply chain, too. Thus, we changed the name of the distributor to the agent. Moreover, interview results revealed that butchers are commonly employed in meat and poultry supply chain. However, since butchers act as a traditional market, we did not add the butcher to analyze but added to generic framework. Table 28 shows some of the quotations that industry experts mentioned during the interviews.

Table 28: Quotations from the Meat and Poultry Industry Experts

Expert	Comment about a stakeholder group	Quotation
M5	Animal farm	<i>At the beginning of each year, we renew our contract with animal farms. Thus, they provide cattle to our facility only.</i>
M4	Coop	<i>The livestock is raised in coops and transported to our facility while they are alive.</i>
M5	Slaughterhouse	<i>Alive livestock is not transported to our facility. We buy carcasses. The livestock is cut in the slaughterhouse and then transported to our facility.</i>
M5	Agent (distributor)	<i>We have a sister company (our agent) who is responsible for all our storage and transportation activities.</i>
R4	Butcher	<i>Traditionally, the community used to buy meat from butchers, and they are familiar with butcher concept. Thus, in our every store, we have a butcher corner so that we</i>

provide a similar experience to our customers.

Resource: Compiled by author

Moreover, the interviews revealed that not all of the listed stakeholder groups directly deal with food loss in their facilities. Thus, before determining the salience of stakeholders, stakeholders who do not deal with food loss were excluded from the list. The excluded stakeholder groups are suppliers, animal producers and breeders association (agricultural cooperatives), financial institutions, policymakers and regulators, unions, packaging companies, research centres and institutes, societies and competitors. Table 29 provides some quotations from the experts who mention about the exclusion of some stakeholder groups.

Table 29: Quotations from Meat and Poultry Industry Experts

Expert	Name of the stakeholder	Quotation
M5	Supplier	<i>Our animal farmers buy fodder and equipment from their first-tier supplier. In fact, we set strict rules about first-tier suppliers of our animal farmers, because fodder is a key element in cattle farming. But they are not part of the food loss problem.</i>
M4	Supplier	<i>We have hatching egg suppliers, and we have coops which are attached to us via contractual relationships. Once we get the hatching eggs, we transport them to our coops, and they raise the eggs. We don't experience food loss with our first-tier suppliers.</i>
M5	Animal producers and breeders association	<i>These type of organizations offer training to improve raising techniques and or help individual farmers. They support our farmers.</i>
M4	Financial institution	<i>Financial institutors are one of the biggest supporters of us. They help us to grow our business yet they don't deal with the food loss.</i>

Food security certificate inspector	Policy makers and regulator	<i>Actually, regulators are closely related to the amount of lost food on the supply chain and try to identify the solutions to overcome the loss. But they are not part of the problem.</i>
M5	Union	<i>We have a couple of trade unions who help us to find new customers for exporting our finished products.</i>
P1	Packaging company	<i>We supply packaging materials, and we only produce those materials and transport them to our customers' facilities. We don't deal with any food in our facilities.</i>
Food security certificate inspector	The research centre and institution	<i>Research centres can be part of the solution. They don't cause food loss.</i>
R4	Society	<i>Society closely monitors the situation about food loss because in our society food is considered as sacred. Thus, we generally see that when a piece of news occurs on media about food loss and waste, society reacts to the news. Yet, they do not have an active role in the food loss occurred at the supply chain.</i>
M5	Competitors	<i>Our competitors' loss some amount of food, probably similar to our loss amount. In the industry, there is a certain level of losses occurs, and we accept that amount as normal.</i>

Resource: Compiled by author

According to results of thematic analysis, animal farms, slaughterhouse, traders who import, food manufacturers, agents, wholesalers, traders who import and logistics service providers were identified as the critical upstream and midstream stakeholders for meat and poultry supply chain. After completing the identification of CUMSs, the next stage is classification of the CUMSs. For this purpose, the method which was explained in the methodology section, was employed. After the analysis which is

conducted according to Tsoufas et al. (2019)’s protocol, the classification of the CUMSs is shown in the Table 30.

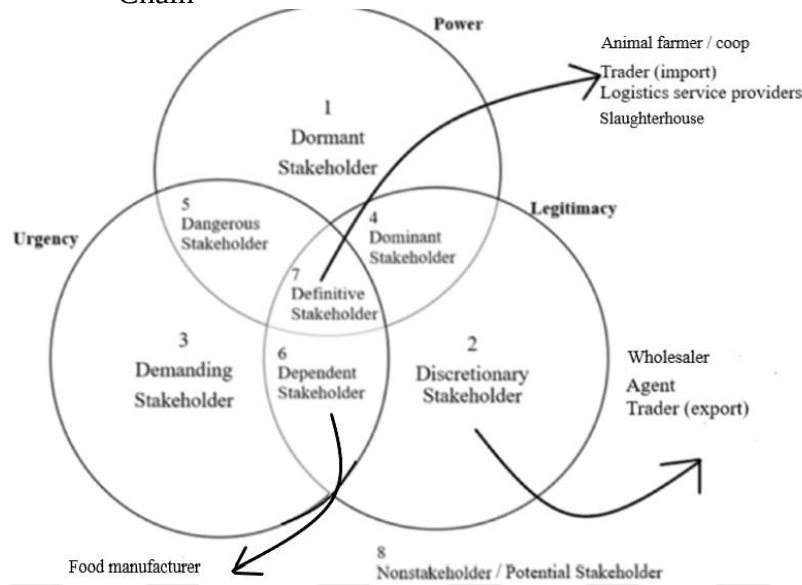
Table 30: Classification of CUMSs for Meat and Poultry Supply Chain

Stakeholder	Legitimacy	Power	Urgency	Stakeholder Type	Stakeholder Salience
Animal farms/coops	High	Medium	Medium	<i>Definitive</i>	<i>High</i>
Slaughterhouse	Medium	Low	Low	<i>Definitive</i>	<i>High</i>
Trader (import)	Medium	Medium	Low	<i>Definitive</i>	<i>High</i>
Food manufacturer	Medium	Absent	High	<i>Dependent</i>	<i>Expectant</i>
Agent	High	Absent	Absent	<i>Discretionary</i>	<i>Latent</i>
Wholesaler	Low	Absent	Absent	<i>Discretionary</i>	<i>Latent</i>
Trader (export)	High	Absent	Absent	<i>Discretionary</i>	<i>Latent</i>
Logistics service provider	High	High	High	<i>Definitive</i>	<i>High</i>

Resource: Compiled by author

Analysis results reveal that four out of eight stakeholder groups are classified as definitive stakeholders meaning that these stakeholder groups have all three attributes. Animal farms/coops, slaughterhouse, trader who import raw materials, and logistics service providers are grouped as definitive stakeholders. According to Mitchell et al. (1997), definitive stakeholders have high salience. Food manufacturer is classified as dependent stakeholders. Dependent stakeholders have urgency and legitimacy attributes at the same time (Mitchell et al., 1997). Agent, wholesaler, and trader who export finished products are classified as discretionary stakeholder according to analysis. Discretionary stakeholders have one attribute, which is legitimacy, and discretionary stakeholders are classified as latent stakeholders. Figure 24 shows the CUMSs on Mitchell’s Venn diagram.

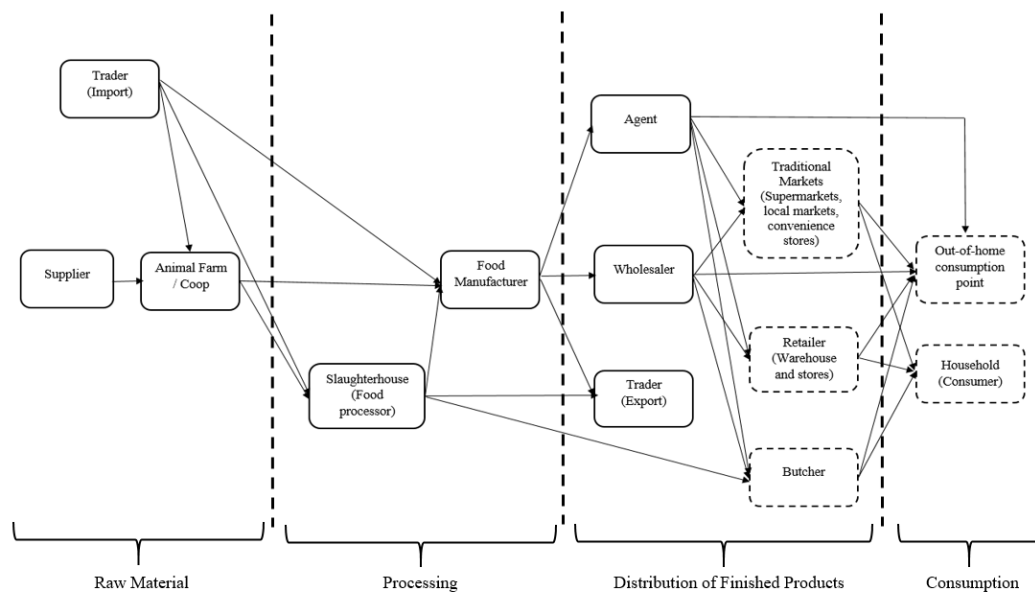
Figure 24: Classification of CUMSs on Venn diagram for Meat and Poultry Supply Chain



Resource: Compiled by author

Based on the interview results, Figure 25 shows the generic meat and poultry supply chain framework in Turkey. To ensure holistic viewpoint, the created food supply chain framework includes all supply chain stakeholders. The CUMSs were provided in strict line rectangles; while rest of the stakeholders were provided in dashed line rectangles on the figure.

Figure 25: Generic Meat and Poultry Product Supply Chain



Resource: Compiled by author

Similar to other food supply chains, meat and poultry supply chain also start with first-tier suppliers. These suppliers provide fodder, equipment, medicine for meat and poultry industry and additionally hatching eggs for the poultry industry. Generally, food manufacturers make contracts with animal farms and coops. Thus, animal farms and coops raise the livestock on behalf of food manufacturers. Moreover, food manufacturers also set rules about the first tiers suppliers of the animal farms and coops, which enables the control over the fodders which are used for feeding the animals.

Moreover, since the demand does not meet the supply and due to economic reasons, importing livestock has become a widely accepted approach in the Turkish meat industry. The imported products can be either alive or carcass. Alive livestock is sent either to the animal farm to raise or slaughterhouse. The carcass is transported to food manufacturing facilities directly. In the meat industry, when raising livestock is completed, animals are transported to the slaughterhouse since some of the meat manufacturers do not have slaughterhouse facility in their factory. While in the poultry industry, raised chickens are directly transported to food manufacturers.

In the food manufacturers, livestock is processed and packaged and become ready for transportation. Traders, who export finished meat products, wholesalers and agents are supplied by food manufacturers. The export of meat and poultry products were enabled via the trader. Besides, food manufacturers distribute finished products by combining wholesalers and agent. Since meat and poultry products require cold chain transportation, they prefer to use their agents, which enables them to control the shipments.

Nevertheless, especially for traditional distribution channels, food producers also work with wholesalers as well. Also, butchers are an essential part of the supply chain because the customers commonly prefer it. Slaughterhouses, agents and wholesalers supply finished products to butchers. Both wholesalers and agents supply finished meat and poultry products to traditional markets, retailers, butchers and out-of-home consumption points.

Households and out-of-home consumption are the last stages of the meat and poultry supply chain. Out-of-home consumption points are fed by agents, traditional

markets, wholesalers, retailers and butchers; while households supply their needs from traditional markets, retailers and butchers.

5.1.2.4. Identification and salience of stakeholders in fruits and vegetable supply chain

To identify and classify the stakeholder in the fruit and vegetable supply chain, fifteen interviews were conducted with different experts from the fruit and vegetable industry. Two interviews were conducted with farmers. Seven interviews were conducted with executives from fruit and vegetable processors. One interview was conducted with a retailer; while another interview was conducted with a wholesaler. 2 interviews were completed who are transportation executives who transport raw and finished fruit and vegetable products. One interview was conducted with an executive from the packaging industry and one interview was conducted with a food security certificate inspector.

Based on the interview results, the name of some stakeholder groups was combined, renamed, added or removed from the initial list, which was shown in Table 21. Fruit and vegetable supply chain also has different stakeholders like what I have observed in fats and oil, milk and dairy products and meat and poultry supply chains. The market hall, harvested fruit and vegetable wholesaler and bazaars are the stakeholders that we have in Turkish fruit and vegetable supply chain. Market halls are places where harvested fruit and vegetable wholesalers and farmers send their products. Sellers in bazaars, retailers, wholesalers, processors, manufacturers can procure freshly harvested products from market halls. Another stakeholder in the fruit and vegetable supply chain is freshly harvested fruit and vegetable wholesaler. For small farmers finding a customer and selling the freshly harvested fruits and vegetables can be difficult; thus, they prefer to work with wholesalers. These wholesalers procure a particular type of fruits or vegetables from different farmers and then sell collected products to processors, manufacturers and bazaars. Bazaars are other stakeholders in the fruit and vegetable supply chain. Since bazaars are fed by the farmers, market halls and freshly harvested fruit and vegetable wholesalers, households prefer to buy fresh fruit and vegetable from there. Since bazaars are not one of the upstream or midstream

stakeholders, we did not include it to analysis; however, we added bazaars to generic framework. Table 31 shows some of the quotations that industry experts mentioned during the interviews.

Table 31: Quotations from the Fruit and Vegetable Industry Experts

Expert	Comment about a stakeholder group	Quotation
R4	Market hall	<i>We work with market halls from different cities. For example, when orange time starts, our procurer, who is located in Antalya goes to Antalya market hall, and they buy oranges on behalf of the retailer and sent to the central warehouse of the retailer.</i>
F3	Freshly harvested fruit and vegetable wholesaler	<i>We sell our harvested products to the wholesaler. They have close relations with producers and markets hall. In our village, all farmers sell their freshly harvested products to the same wholesaler.</i>
F1	Fruit and vegetable bazaar	<i>Some of the farmers in our village sell their products in bazaars instead of selling to a wholesaler, market hall or producers.</i>

Resource: Compiled by author

Moreover, the interviews revealed that not all of the listed stakeholder groups directly deal with food loss in their facilities. Thus, before determining the salience of stakeholders, stakeholders who do not deal with food loss were excluded from the list. The excluded stakeholder groups are suppliers, agricultural cooperatives, financial institutions, policymakers and regulators, unions, packaging companies, research centres and institutes, societies and competitors. Table 32 provides some quotations from the experts who mention about the exclusion of some stakeholder groups.

Table 32: Quotations from Fruit and Vegetable Industry Experts

Expert	Name of the stakeholder	Quotation
F3	Supplier	<i>We buy seeds and pesticide from our supplier. Both the loss and gain belongs to us. They do not involve these issues.</i>
F1	Agricultural cooperatives	<i>Our cooperative supports us in terms of marketing and finding new customers.</i>
FV6	Financial institution	<i>Financial institutions are one of the important stakeholders for us, yet they are not involved in production activities.</i>
Food security certificate inspector	Policy makers and regulator	<i>Actually, regulators are closely related to the amount of lost food on the supply chain and try to identify the solutions to overcome the loss. But they are not part of the problem.</i>
FV8	Union	<i>Our blue-collar workers are a member of a union. But the primary responsibility of the union is to blue-collar employees, they do not deal with the production and or loss amounts.</i>
P1	Packaging company	<i>We supply packaging materials, and we only produce those materials and transport them to our customers' facilities. We don't deal with any food in our facilities.</i>
Food security certificate inspector	The research centre and institution	<i>Research centres can be part of the solution. They don't cause food loss.</i>
R4	Society	<i>Society closely monitors the situation about food loss because in our society food is considered as sacred. Thus, we generally see that when a piece of news occurs on media about food loss and waste, society reacts to the news. Yet, they do not have an active role in</i>

the food loss occurred at the supply chain.

FV5	Competitors	<i>We are in the same business, and our competitors will also deal with a similar amount of food loss in their facilities as we do. Yet, we cannot make assumptions about the loss.</i>

Resource: Compiled by author

According to results of thematic analysis, agricultural farmers, traders who import, freshly harvested fruit and vegetable wholesalers, market halls, fruit and vegetable processors, food manufacturers, traders who export, wholesalers and logistics service providers were identified as the critical upstream and midstream stakeholders for fruit and vegetable supply chain. After completing the identification of CUMSs, the next stage is classification of the CUMSs. For this purpose, the method which was explained in the methodology section, was employed. After the analysis which is conducted according to Tsoulfas et al. (2019)'s protocol, the classification of the CUMSs is shown in the Table 33.

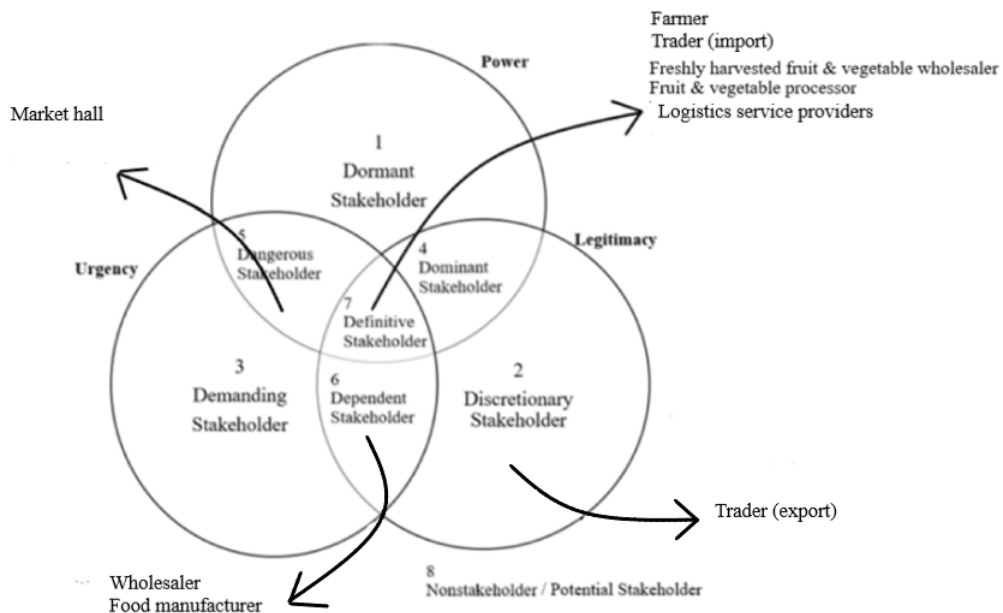
Table 33: Classification of CUMSs for Fruit and Vegetable

Stakeholder	Legitimacy	Power	Urgency	Stakeholder Type	Stakeholder Salience
Agricultural farmer	Medium	Very high	Low	<i>Definitive</i>	<i>High</i>
Trader (import)	High	Medium	Low	<i>Definitive</i>	<i>High</i>
Freshly harvested fruit and vegetable wholesaler	Low	Medium	High	<i>Definitive</i>	<i>High</i>
Market hall	Absent	High	High	<i>Dangerous</i>	<i>Expectant</i>
Fruit and vegetable processor	High	High	High	<i>Definitive</i>	<i>High</i>
Food manufacturer	High	Absent	High	<i>Dependent</i>	<i>Expectant</i>
Trader (export)	Medium	Absent	Absent	<i>Discretionary</i>	<i>Latent</i>
Wholesaler	Low	Absent	Low	<i>Dependent</i>	<i>Expectant</i>
Logistics service provider	Medium	Low	Medium	<i>Definitive</i>	<i>High</i>

Resource: Compiled by author

Analysis results reveal that five out of nine stakeholder groups are classified as definitive stakeholders meaning that these stakeholder groups have all three attributes. Farmers, traders who import raw materials, freshly harvested fruit and vegetable wholesaler, fruit and vegetable processor, and logistics service providers are classified as definitive stakeholders. According to Mitchell et al. (1997), definitive stakeholders have high salience. The market hall is classified as dangerous stakeholders. Dangerous stakeholders have the power and urgency attributes and classified as expectant stakeholders. Figure 26 shows the CUMSs on Mitchell's Venn diagram.

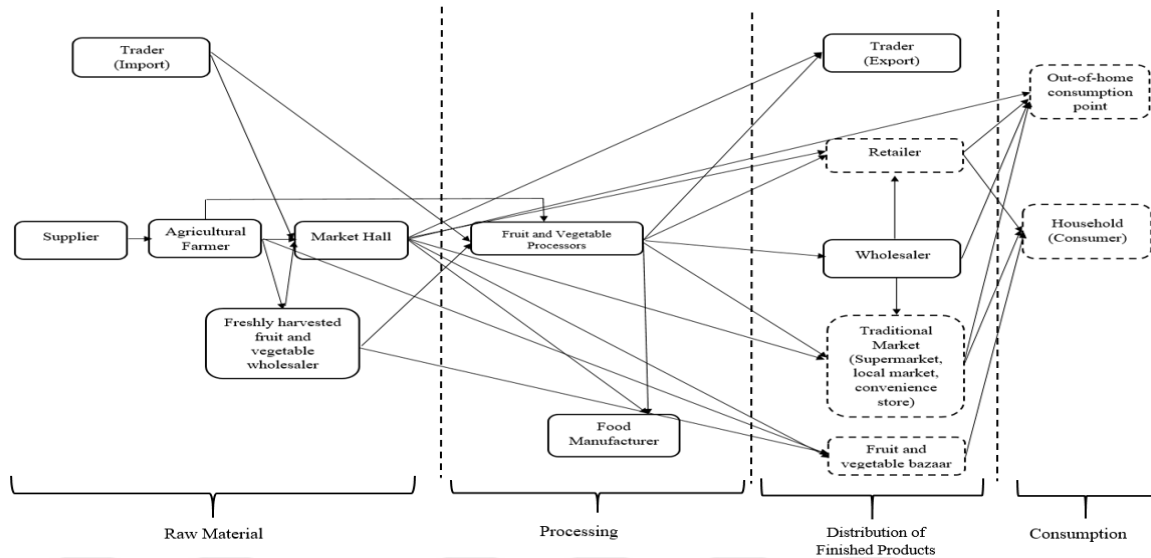
Figure 26: Classification of CUMSs on Venn diagram for Fruit and Vegetable Supply Chain



Resource: Compiled by author

Based on the interview results, Figure 27 shows the generic fruit and vegetable supply chain framework in Turkey. To ensure holistic viewpoint, the created food supply chain framework includes all supply chain stakeholders. The CUMSs were provided in strict line rectangles; while rest of the stakeholders were provided in dashed line rectangles on the figure.

Figure 27: Generic Fruit and Vegetable Supply Chain



Resource: Compiled by author

Fruit and vegetable supply chain begins with first-tier suppliers. These suppliers provide seeds, equipment and agricultural pesticides to agricultural farmers. With utilizing this equipment, agricultural farmers plant seeds. After the plants are grown and harvested, agricultural farmers take harvested products to wholesaler, market hall or fruit and vegetable bazaar. Besides, if fruit and vegetable processors make a contract with agricultural farmers, farmers grow the plants only for the processor. Thus, farmers also supply harvested crops directly to processors as well. After the wholesaler reaches a certain amount of tonnage, the wholesaler can sell it to either market hall, fruit and vegetable processors, or fruit and vegetable bazaar.

Since some of the fruit and vegetable such as tropical fruits are not grown in Turkey, they are imported. Thus, traders who import fruits and vegetables, supply fruits and vegetables to either market hall or fruit and vegetable processors. Market halls are one of the big players in Turkish fruit and vegetable food supply chain. They supply fruit and vegetable to traders who export, retailers, traditional markets, bazaars and out-of-home consumption points. In their facilities, processors conduct quality assurance, wash the fruits and vegetables, separate the fruits and vegetables according to sizes, process fruits and vegetables such as drying, canning, or freezing and then package the processed or fresh fruits and vegetables. Generally, raw fruit and vegetable sellers are considered as fruit and vegetable processors. These processors supply

products to traders, who export, retailers, wholesalers, traditional markets and food manufacturers. Food manufacturers take the finished products and process them and reveal a new product such as a frozen pizza manufacturer. This manufacturer procures cleaned and cut mushroom from the processor and use them to prepare pizza.

The fruit and vegetable distribution channel consist of traders, retailers, wholesalers, traditional markets and bazaars. The export of fruit and vegetable products are enabled via the trader. For traditional sale channels, food producers prefer to work with wholesalers. Processors supply products to retailers directly themselves or via wholesalers. In Turkish fruit and vegetable supply chain, bazaars have an essential place. Consumers who think that most fresh fruits and vegetables can be found at bazaars, mainly prefer to buy from bazaars. Bazaars supply their products from farmers, market halls and or freshly harvested fruit and vegetable wholesalers.

Households and out-of-home consumption are the last stages of the fruit and vegetable supply chain. Out-of-home consumption points are fed by market hall, processors, retailers, wholesalers and traditional markets; while households supply their needs retailers, traditional markets and bazaars.

5.1.3. Summary

The first phase of the thesis was identifying stakeholders, who deal with food loss in their facilities and their salience. For this purpose, 25 articles, which empirically revealed stakeholder groups in their studies, were examined. According to this review, twenty-nine stakeholder groups were defined. To validate the identified stakeholder groups in different food types which are fats and oil, milk and dairy products, meat and poultry and fruit and vegetable, interviews with stakeholders were conducted. Nine, eight, nine and fifteen interviews were conducted for each food supply chain groups; fats and oil, milk and dairy products, meat and poultry, and fruit and vegetable supply chain, consecutively. After removing some stakeholders (because of the scope of the food loss definition) and the stakeholder groups who deal with food loss, are provided in Table 34 across four supply chains.

Table 34: Stakeholders who Deal with Food Loss across Different Food Supply Chains

Name of the stakeholder	FO	MDP	MP	FV
Farmer	X			X
Dairy farmer		X		
Animal farm / coop			X	
Slaughterhouse			X	
Milk collection point		X		
Mil processor (food processor)		X		
Oil extraction facility	X			
Raw oil wholesaler	X			
Freshly harvested fruit and vegetable wholesaler				X
Trader (import)	X		X	X
Fats and oil refinery (food processor)	X			
Trader (export)	X	X	X	X
Market hall				X
Fruit and vegetable processor (food processor)				X
Wholesaler	X	X	X	X
Distributor	X			
Agent		X	X	
Food manufacturer	X	X	X	
Logistics service provider	X	X	X	X

Resource: Compiled by author

In Table 34, FO means fats and oil supply chain, MDP means milk and dairy product supply chain, MP means meats and poultry supply chain and FV means fruit and vegetable supply chain. As it can be observed from the Table 60, these stakeholders deal with food loss.

The classification of stakeholders through salience was completed according to stakeholders' possession of attributes (Mitchell et al., 1997). High salient

stakeholders influence stakeholders. The requests come from high salient stakeholder groups are taken into consideration more seriously than the other stakeholders. Compared to high salient stakeholders, these group are more passive and ready to act the requests comes from the high salient stakeholders. Latent stakeholders have limited sources and depend the high salient stakeholders generally. Classification of the upstream and midstream stakeholders based on their salience for four type of supply chain is provided in Table 35.

Table 35: Classification of Stakeholders based on Food Supply Chain Types

	Latent	Expectant	High
Fats and oil	Trader (export)	Distributor	Farmers
		Food manufacturer	Oil extraction facility
		Wholesaler	Raw oil wholesaler
			Trader (import)
			Fats and oil refinery (food processor)
			Logistics service provider
Milk and dairy products	Trader (export)	Food manufacturer	Dairy farmers
	Agent		Milk collection point
	Wholesaler		Milk processor (food processor)
Meat and sausage	Agent	Food manufacturer	Animal farmers/coop
	Wholesaler		Slaughterhouse (food processor)
	Trader (export)		Logistics service provider
		Trader (export)	Market hall

Fruit and vegetable	Wholesaler	Trader (import)
	Food manufacturer	Freshly harvested fruit and vegetable wholesaler
		Fruit and vegetable processor
		Logistics service provider

Resource: Compiled by author

Table 35 supports the expectation of the upstream and midstream stakeholders are classified differently. Next section (5.2) reveals identified and classified logistics-related critical food loss drivers based on literature review and interviews with stakeholders who are identified in this section (5.1).

5.2. FINDINGS OF LOGISTICS-RELATED CRITICAL FOOD LOSS DRIVERS

5.2.1. Results of the literature review

As it is explained the chapter four, the first stage of the identification and classification of logistics-related critical food loss drivers (LCFLD) is setting the research objectives for the analysis, and define the conceptual boundaries. Thus, the purpose of the analysis is to identify and classify LCFLD. Based on the explained literature review research process, the literature review was conducted. As a result, 71 articles were gathered and examined, and it has been revealed that 28 of the articles solely focused on the household/consumer food waste drivers such as (Aschemann-Wtitzel et al., 2015; Lanfranchi et al., 2016; Stefan et al., 2013; Stancu et al., 2016; Jörissen et al., 2015). Moreover, 16 of the articles only focused and examined the food waste drivers in the food sector such as school canteen (Derqui et al., 2016, 2018; Liu et al., 2016), hospitality industry (Pirani and Arafat, 2014) and restaurants (Yu et al. 2016). Thus, these articles were removed from the analysis, and literature review were

conducted with 27 studies. Table 36 shows the identified logistics-related critical food loss drivers as a result of the literature review analysis.

The transportation units which are not suitable for transporting small-grain products, the transportation units which is not suitable for carrying food, and the products which are placed directly into the transportation units without any packaging are some of the examples of inappropriate transportation conditions. These type of wrong transportation implementations lead to crushing, breaking (Beretta et al., 2013; Canali et al., 2017) and or contamination. Although crushed and broken products can be safe for consumption, since the shape of the product is changed consumers will be reluctant to buy the damaged products with the same price (Kulikovskaja and Aschemann-Witzel, 2017; Di Muro et al., 2016). Besides, since the contaminated product cannot be consumed due to food safety reasons, improper transportation conditions lead to food loss.

Table 36: List of Identified Logistics-related Critical Food Loss Drivers

Driver	Examples	Reference
Improper conditions	transportation The transportation units which are not suitable for transporting small-grain products The transportation units which is not suitable for carrying food The products which are placed directly into the transportation units without any packaging	Beretta et al., 2013; Manzocco et al., 2016; Canali et al., 2017
Logistics hold-ups	Delays in raw material transportation Delays in finished product transportation	Göbel et al., 2015; Gogo et al., 2017
High transportation cost	If the transportation cost exceeds the value of the harvested products, farmers leave the crops on the land	Chauhan et al., 2018
Inadequate infrastructure	transportation Poor road conditions Weak road-rail network Poor logistics network design	Balaji and Arshinder, 2016; Irani and Sharif, 2016; Arivazhagan et al., 2017; Gogo et al., 2017; Chauhan et al., 2018; Stangherlin and de Barcellos, 2018; Gogo et al., 2018
Lack of cold chain equipment	Shortage of refrigerated carriers	Mena et al., 2011; Ma et al., 2015; Balaji and Arshinder, 2016; Arivazhagan et al., 2017; Porat et al., 2018
Poor transportation handling	Improper storing inside the transportation unit Improper storing inside the reefer containers Accidents occurred during loading and unloading	Mena et al., 2011; Balaji and Arshinder, 2016; Manzocco et al., 2016; Arivazhagan et al., 2017; Canali et al., 2017; Gogo et al., 2017

Lack of storage infrastructure	Shortage of storage space Shortage of storage shelves	Ma et al., 2015; Irani and Sharif, 2016; Manzocco et al., 2016; Beausang et al., 2017; Chauhan et al., 2018; Stangherlin and de Barcellos, 2018
Improper storage	Exposing raw and finished food to humid, sunlight, wrong temperatures during storing Piling up perishable products in the storage	Beretta et al., 2013; Willersinn et al., 2015; Irani and Sharif, 2016; Canali et al., 2017; Raak et al., 2017; Aamir et al., 2018
Improper conditions of storage	Storage unit which is unsuitable for food preservation due to dirt, humidity	Canali et al., 2017
Lack of cold storage infrastructure	Lack of cold storage hangars in airports Shortage of cold storage space Shortage of plug-in seaports	Ma et al., 2015; Balaji and Arshinder, 2016; Manzocco et al., 2016; Priefer et al., 2016; Arivazhagan et al., 2017; Gogo et al., 2017; Raak et al., 2017; Chauhan et al., 2018; Stangherlin et al., 2018; Gogo et al., 2018; Porat et al., 2018
Poor storage handling	Accidents during loading and unloading to storage units	Canali et al., 2017; Gogo et al., 2017; Gogo et al., 2018
Inappropriate shelf space	Narrow shelf spaces Not enough spaces for display the products	Mena et al., 2011
Lack of material handling equipment	Shortage of lifting gear Shortage of forklift	Canali et al., 2017
Lack of stringent inventory policy	Supply chain members order without knowing their stakeholders' inventory policy Incorrect application of inventory turnover	Lebersorger and Schneider, 2014; Ma et al., 2015; Balaji and Arshinder, 2016; Irani and Sharif, 2016; Priefer et al., 2016; Canali et al., 2017

Inaccurate forecasting

The unpredictability of supply and demand volumes and consequently overproduction and demand volatility
Limited predictability of actual customer demand
Wrong demand forecasting
Seasonality

Mena et al., 2011; Priefer et al, 2016; Tropm et al., 2016; Beausang et al., 2017; Canali et al., 2017; Raak et al., 2017; Redlingshöfer et al., 2017; Campbell and Munden-Dixon, 2018; Teller et al., 2018

Poor ordering implementations

Ordering the wrong product
Unable to place the order on time
Ordering the wrong amount

Mena et al., 2011; Lebersorger and Schneider, 2014; Priefer et al., 2016

Suboptimal use of packaging functions

Problems related to packaging material nature
Not enough mechanical protection
Damaged packaging

Mena et al., 2011; Lebersorger and Schneider, 2014; Willersinn et al., 2015; Manzocco et al., 2016; Priefer et al., 2016; Thyberg and Tonjes, 2016; Arivazhagan et al., 2017; Canali et al., 2017; Gogo et al., 2017; Kliaugaitė and Kruopinė, 2018; Liljestränd, 2017; Raak et al., 2017; Gogo et al., 2018

Lack of communication

Absence of information dissemination
Lack of information sharing

Mena et al., 2011; Balaji and Arshinder, 2016; Kliaugaitė and Kruopinė, 2018; Raak et al., 2017; Chauhan et al., 2018

Resource: Compiled by author

Delays in transportations (logistics hold-ups) are another reason for the loss in the supply chain (Göbel et al., 2015; Gogo et al., 2017). Raw food products (such as raw milk, carcasses, and freshly harvested fruits and vegetables) are easily perishable. Thus they need to be transported to the processor/manufacturer or relevant stakeholders immediately due to both safety reasons and concerns about losing nutritional values. Therefore, any delay will impact the quality of the finished product or make the raw material unusable, which leads to a loss in the supply chain.

If transportation costs exceed the sale value of produce, then farmers prefer to leave it in the field instead of sending it to the market (Chauhan et al., 2018). In this case, unharvested crops become waste. Inadequate transportation infrastructure is another food loss driver which is observed in the literature. Poor logistics infrastructure such as poor road conditions (Arivazhagan et al., 2017; Gogo et al., 2017; 2018), and weak road-rail networks (Chauhan et al., 2018) cause food loss (Balaji and Arishinder, 2016; Irani and Sharif, 2016; Stangherlin and de Barcellos, 2018).

Lack of cold chain equipment such as shortage of refrigerated carriers leads to food loss especially in the food types which require cool or cold chain transportation (Mena et al., 2011; Ma et al., 2015; Balaji and Arshinder, 2016; Arivazhagan et al., 2017; Porat et al., 2018).

Poor transportation handling, such as improper storing inside the transportation unit or reefer containers, cause food loss in the supply chains. Improper storing inside the transportation unit, such as not stabilizing the pallets inside the transportation unit will end up with food loss because unstable pallets will collide each other or fall and damage the products. In a reefer container, the maximum loading is indicated by maximum loading lines, which are found on the internal wall of the container. In cases where these loading lines are exceeded, container cooling is disrupted, and as a result, deterioration occurs in the food.

Lack of food storage infrastructure leads to food loss in the supply chain (Ma et al., 2015; Irani and Sharif, 2016; Manzocco et al., 2016; Beausang et al., 2017; Chauhan et al., 2018; Stangherlin and de Barcellos, 2018). Raw food products such as milk, meat and freshly harvested fruit and vegetable need to be preserved at certain conditions. If space or shelf shortage occurs for these products, since they cannot be preserved in required conditions, they become waste.

Literature review revealed that improper storage leads to food loss in the supply chain (Beretta et al., 2013; Willersinn et al., 2015; Irani and Sharif, 2016; Canali et al., 2017; Raak et al., 2017; Aamir et al., 2018). Different products types require different temperature regimes while transporting and storing so, exposing raw and finished products to the wrong temperature will cause spoiling which puts the food in a position that cannot be consumed (Hart, 1998; Brosnan and Sun, 2001). Similarly, if a dry food exposes to humid and or sunlight, the texture of the food deteriorates, and food becomes inconsumable. Moreover, piling up the sensitive foods such as peaches, avocado, butter, the cheese will cause crushes on the package or itself of the product. Since the consumers and retailers put strict requirements for the appearance of the products, they are less willing to buy these products and the products which remained on displays eventually deteriorate and become waste.

Improper conditions of a storage unit such as dirty, humidity or do not meet the food safety requirements, cause food loss (Canali et al., 2017). Another driver of food loss is lack of cold storage infrastructure (Ma et al., 2015; Balaji and Arshinder, 2016; Manzocco et al., 2016; Priefer et al., 2016; Arivazhagan et al., 2017; Gogo et al., 2017; Raak et al., 2017; Chauhan et al., 2018; Stangherlin and de Barcellos, 2018; Gogo et al., 2018; Porat et al., 2018). While each year, approximately 100 tons of products which requires cold or cool temperate regimes are shipped from airports, no cold storage units or hangars are found at the airports. Especially during delays, this situation leads to loss. Similarly, in seaports, there is not enough capacity for each reefer to be plugged in. Thus, during busy times, losses occur due to the shortage of plugins in seaports. As it is explained above, if a product which requires a specific temperature regime, cannot be stored in that temperature, deterioration or nutritional value loss occur (Hart, 1998; Brosnan and Sun, 2001).

Poor storage handling cause loss, as well (Canali et al., 2017; Gogo et al., 2017; Gogo et al., 2018). Accidents occur during loading, and unloading leads to breaking on products with glass or tearing on packages. In both cases, because of the contamination possibility or breaching the food security requirements, food cannot be consumed and needs to be destroyed.

Mena et al. (2011) identified that inappropriate shelf space causes food loss, especially for the food which requires cool or cold temperature regimes. When there

is not having enough space for these type of products, products cannot be preserved under the required temperature regimes, and they will deteriorate. Lack of material handling equipment such as lifting gears and forklifts lead to food loss (Canali et al., 2017) since the deficiency of these tools retard the handling process and cause nutritional decrease on the food or thawing.

Not having a stringent inventory policy leads to food loss (Lebersorger and Schneider, 2014; Ma et al., 2015; Balaji and Arshinder, 2016; Irani and Sharif, 2016; Priefer et al., 2016; Canali et al., 2017). Supply chain members who do not know their stakeholders' inventory policy will probably end up ordering too much or too less. Similarly, as a result of incorrect application of inventory turnover, stakeholders will not be able to order precisely and will end up in loss.

According to the literature review, inaccurate forecasting is another food loss driver in the food supply chain. Another reason of food loss is the unpredictability of supply and demand volumes due to weather or seasonality (Mena et al., 2011; Campbell and Munden-Dixon, 2018; Teller et al., 2018). Additionally, limited predictability of the actual demand also leads to food loss (Tropm et al., 2016; Beausang et al., 2017; Canali et al., 2017). Wrong demand forecasting also leads to loss (Priefer et al., 2016; Raak et al., 2017; Redlingshöfer et al., 2017). Farmers face pressure to overproduce for various reasons, such as supply agreements with retail chains, seasonal fluctuations, government subsidies, fear of adverse weather conditions, and infestations or contamination. If demand does not meet the increased supply, the excess production becomes loss (Beretta et al., 2013; Priefer et al., 2016; Beausang et al., 2017; Canali et al., 2017; Gogo et al., 2017; Redlingshöfer et al., 2017; Campbell and Munden-Dixon, 2018; Chauhan et al., 2018). If the over-produced food cannot be sold on time, it becomes expired. Moreover, when wholesalers and retailers offer promotions and sell extra products without informing food processors, the latter mistakenly consider this as indicating new demand and produce more in response. However, since the demand for promotional sales is temporary, the excess food produced will remain unsold with the food processor and become waste. Poor ordering implementations are another driver of the food loss in the food supply chain (Mena et al., 2011; Lebersorger and Schneider, 2014; Priefer et al., 2016). Ordering the wrong the product, unable to place the order on time and ordering the wrong amount are some

of the commonly seen examples of poor ordering implementations that lead to food loss in the supply chain.

Due to the packaging material's nature, food loss can occur. If the package cannot provide enough mechanical protection, contamination or deterioration occur, and food becomes waste (Ma et al., 2015; Balaji and Arshinder, 2016; Irani and Sharif, 2016; Priefer et al., 2016; Arivazhagan et al., 2017; Canali et al., 2017; Gogo et al., 2017; Raak et al., 2017; Gogo et al., 2018). Consumers and retailers' requests about strict appearance also valid for packaging as well. Thus, consumers do not prefer to buy products whose package is damaged. Damaged packaging causes food loss (Mena et al., 2011; Lebersorger and Schneider, 2014; Thyberg and Tonjes, 2016; Liljestrand, 2017; Manzocco et al., 2016; Willersinn et al., 2015; Priefer et al., 2016; Canali et al., 2017; Kliaugaitė and Kruopinė, 2018). Poor quality packaging materials directly reduce product shelf life while inappropriate packing material usage increases the risk of contamination.

According to literature, lack of communication also leads to food loss (Mena et al., 2011; Balaji and Arshinder, 2016; Kliaugaitė and Kruopinė, 2018). Absence of information dissemination (Chauhan et al., 2018) and lack of information sharing (Raak et al., 2017) are two important reasons for food loss.

As a result of the literature review, 17 logistics-related critical food loss drivers are identified to transportation, warehousing, inventory management, packaging and communication. To understand whether these identified drivers are valid in the Turkish food supply chains, interviews were conducted with industry experts. The next sections show the interview results and food loss drivers for each food supply chain type.

5.2.2. Results of interviews

To verify whether the identified LCFLD causes food loss in the food supply chain, I have conducted interviews with experts from four food industries. I have completed a total of 39 interviews as a result. Interviews revealed that not all of the identified LCFLDs are valid for each supply chain types. Since some of the identified LCFLDs are not valid for supply chains in Turkey, unrelated LCFLDs were removed

from the analysis (inadequate transportation infrastructure, improper conditions of storage, lack of communication). Moreover, based on the conducted interviews, a new LCFLD were added to the analysis (inappropriate secondary packaging, improper handling equipment). Additionally, the identified LCFLD were grouped considering the logistics functions. The next section gives detailed information about each food supply chain's LCFLDs and how they were caused food loss in the supply chain.

5.2.2.1. Logistics-related critical food loss drivers for fats and oil supply chain

To identify LCFLDs, a total of thirteen interviews were conducted from identified stakeholder groups. Two of these interviews were conducted with farmers; two interviews were conducted with executives from fats and oil producer (refineries). Four interviews were conducted with retailers who sell finished products. One interview was conducted with a wholesaler who sells finished fats and oils products. In addition, three interviews were conducted with logistics service providers who transport raw oils and finished oils, both domestic and overseas. One interview was conducted with an expert who is food security, certificate inspector.

According to the literature review and thematic analysis, three types of LCFLD identified in the fats and oil supply chain. Transportation-related drivers, warehousing-related drivers and inventory management related drivers are identified as the main drivers. Four sub-drivers are identified for the transportation-related drivers. Improper transportation conditions, lack of cold chain equipment, poor transportation handling and improper handling equipment are the identified sub-drivers. Although improper handling equipment is not initially found as the result of thematic analysis, based on the interview results, this sub-criteria also added.

Four sub-drivers are identified for the warehousing-related sub-drivers. Lack of cold storage infrastructure, poor storage handling, inappropriate shelf space and lack of material handling equipment are identified sub-drivers for the fats and oil supply chain. Thematic analysis revealed that three sub-drivers about inventory management function lead to food loss in the fats and oil supply chain. Lack of stringent inventory policy, inaccurate forecasting and poor order implementation are the sub-drivers of

inventory management. According to thematic analysis, no driver has been identified from packaging and communication function. Table 37 shows the identified main and sub-drivers which lead to food loss in the fats and oil supply chain.



Table 37: Main Drivers and Sub-drivers that cause Food Loss in the Fats and Oil Supply Chain

Driver	Sub-driver	Participant code	Quotation
Transport-related FLD	Improper transportation conditions	T1	<i>Both raw and finished oil needs to be transported in flexitanks. This is the safest way of transportation of high volume liquid. Yet each flexitank can be used only once and then have to be removed and destroyed. But some of the shippers do not want to use flexitank because of the cost and prefer to use other transportation units such as barrels. Most of the time, these cases where flexitank isn't used, are the cases where we face loss.</i>
	Lack of cold chain equipment	O2	<i>In our product range, we have margarine which requires cool temperature regime. To ensure that our products are delivered within the designated temperature, having the right equipment at the right time is utmost important. In the past, we had a problem with this issue with one of our wholesaler couple of times. Instead of using a cold chain, wholesaler shipped the products in a transportation unit without any temperature regime. In the end, all batch melted and we had to re-process the melted products.</i>
	Poor transportation handling	O1	<i>We have products which are stored in glass bottles, and they are shipped regularly. Although our chauffeurs are trained accordingly, in case of a sudden put on the break, the risk of damage is always there. Thus, the pallets need to be stabilized inside the transportation unit. If the pallets are not stabilized, we can lose the entire products inside the transportation unit.</i>
		O2	<i>Although we train our employees about handling the finished products, accidents can still occur. Sometimes our employees drop pallets and damage the packaged finished products, or sometimes forklift operator sticks the forklift forks up products instead of pallets. Our loss rate for this type of accidents is approximately 1-2 per thousand, and we try to decrease this rate constantly.</i>
	Improper handling equipment	T1	<i>A pump used for filling flexitank should not be thinner than 3.5 millimetres, and stitching must be durable for pressure during the loading and unloading. For instance, one of the firms that I am working with has a pump that does not meet the quality standards requirements. Thus, 1 out of in every 20-loading leakage occurs. Almost one-fourth of the product leaks. Since oil firm</i>

Warehousing-related FLD	Lack of cold storage infrastructure	R3	<i>charges this loss from the flexitank producer, they do not see this leakage as a loss. Yet, the finished product, which is in perfect condition for human consumption becomes loss because of the used pump, does not meet the quality standards.</i>
	Poor storage handling	O2	<i>In our retail stores, we don't have enough cold storage capacity. In the past, we had problems due to this reason. The products that we left outside was melted. Most of the time, firms distribute their products directly to our retail stores and also products' processor sends an employee to arrange shelves.</i>
	Inappropriate shelf space	O1	<i>Although we train our employees about handling the finished products, accidents can still occur. Sometimes our employees drop pallets and damage the packaged finished products, or sometimes forklift operator sticks the forklift forks up products instead of pallets. Our loss rate for this type of accidents is approximately 1-2 per thousand, and we try to decrease this rate constantly.</i>
	Lack of material handling equipment	W1	<i>Most of the time, the only cold storage unit in a retailer is the unit which is in the showroom, meaning that store has to preserve all products which require cold storage, at the same place. Some of the products are left outside of the storage unit. Deterioration or melting occurs because of the inappropriate shelf space.</i>
Inventory-related FLD	Lack of stringent inventory policy	W1	<i>Lack of warehousing equipment is quite a problem, especially in traditional markets. Lack of equipment increase the loading and unloading times and especially for the products which require cool, cold or frozen transportation, which increase the possibility of deterioration.</i> <i>It has been observed that traditional markets do not have a strict inventory policy; thus, from time to time, they have a surplus or shortage of products. Both situations affect us severely. Because in one case, our finished product which requires a cold chain, cannot be stored properly. While in another case, our consumers who want to buy our product cannot buy because of retailer branch's wrong inventory calculations.</i>

Inaccurate
forecasting

O1

At the beginning of each year, we prepare our yearly demand forecasts based on our previous year actual sales, and we procure our raw materials based on these forecasts. Yet, we produce products when we receive actual demand. Sometimes because of issues such as volatile changes in the price of the product, our forecasts and actual demand do not match. In those times, we either keep our raw materials in our raw material tanks (because raw oil does not have an expiration date) or we produce as the final product. The best characteristic of our product is that even it is expired, we can collect and re-work on expired products and produce new products. Although we experience loss at this process since we add the loss to our price, we prefer to neglect this amount of loss.

Poor order
implementation

O2

Poor ordering implementation is a problematic issue for us because we organize our production quantities according to the actual order. We do not have a problem with the product with a shelf life of up to 2 years. But when we receive the wrong order in our product with a shelf life approximately six months, it is a problem for us to put back the returned product in the market because big retailers do not want to purchase a product with a remaining shelf life around 2 or less.

Resource: Compiled by author

5.2.2.2. Logistics-related critical food loss drivers for milk and dairy product supply chain

To identify LCFLDs, a total of fourteen interviews were conducted from identified stakeholder groups. Five of these interviews were conducted with experts from milk producers (processors). Four interviews were conducted with retailers. One interview was conducted with a wholesaler. Three interviews were conducted with logistics service providers who transport raw and finished the milk and dairy products. One interview was conducted with food security certificate inspector. Table 38 shows the identified LCFLDs for the milk and dairy product supply chain.

Based on the literature review and thematic analysis, three types of LCFLDs are identified for milk and dairy product supply chain. Transportation-related drivers, warehousing-related drivers and inventory management related drivers are identified as the main drivers. Logistics hold-ups, lack of cold chain equipment and poor transportation handling are the identified sub-drivers of the transportation-related drivers. Five sub-drivers were identified for the warehousing-related drivers regarding the thematic analysis. The identified sub-drivers are improper storage, lack of cold storage infrastructure, poor storage handling, inappropriate shelf space and lack of material handling equipment. Lack of stringent inventory policy, inaccurate forecasting and poor order implementation are the sub-drivers that is identified as inventory management related drivers. According to thematic analysis, no driver has been identified from packaging and communication function. Table 38 shows the identified main and sub-drivers which lead to food loss in the milk and dairy product supply chain.

Table 38: Main Drivers and Sub-drivers that cause Food Loss in the Milk and Dairy Product Supply Chain

Driver	Sub-driver	Participant code	Quotation
Transport-related FLD	Logistics hold-ups	D2	<i>Raw milk needs to be processed within 48 hours. Once the raw milk enters the facility, before the processing, we run quality tests. This means that even when the raw milk comes to our facility, we still have to wait until test results. So, we cannot tolerate any delays, especially for raw milk transportation. If the raw milk delays and pass the 48 hours, we have to dispose of the whole amount.</i>
	Lack of cold chain equipment	D3	<i>In the past, we used to work with a wholesaler. Although we had a contractual relationship and the wholesaler needed to obey the contract, because of the shortage of refrigerated vehicles, they had distributed products with vehicles which do not have temperature control. We noticed this situation after we have started to get complaints and returns from the same wholesaler's customer due to spoilage. We ended the contract because of the breach, and the wholesaler paid the damage.</i>
	Poor transportation handling	D3	<i>If the employee who places down the products inside the transportation unit is not experienced enough, a loss can occur. As a rule, we immobilize each pallet after we place down them. Otherwise, when the truck stops suddenly, all products will slip and damaged.</i>
Warehousing-related FLD	Lack of cold storage infrastructure	D1	<i>Preserving and maintaining the cold chain is one of the most important things that we do. We designed our distribution channel accordingly, and we observed that most of the loss occurs at the retailer's branch. To diminish the loss amount, we provide warehousing service to some of the retailers. Yet, retailers still need to organize their deliveries for branches. We know that they maintain the cold chain regime within warehouses yet, most of the retail branch cannot maintain cold chain regime because of the lack of cold storage infrastructure.</i>

	Improper storage	D1	<i>Finished products are boxed and after that placed on the pallet. Especially for our milk products, we have strict rules for storing. Because after a certain level of weight, the milk boxes are crushed, and we also warn our customers while we make deliveries to their stores.</i>
	Poor storage handling	D5	<i>Although we give high importance on the movement of finished products, sometimes accidents happen. Forklift knives can accidentally stab to finished products instead of a pallet. At that time, we have to unwrap the pallet and remove erupted/fragmented products out of the box. We cannot use these products, and they turn into a loss.</i>
	Inappropriate shelf space	D1	<i>Some of the retail stores have tight shelf spaces, especially for UHT milk. Placing the product without damaging the packaging is really hard in these tight shelves. Thus, products are placed by damaging their package. Customers give importance to the appearance of the package, especially for the products which require cold chain regimes. And when they see damage on the package, they do not want to buy the product. Thus the expiring date will pass while waiting on the inappropriate shelf spaces, milk and dairy products turn into waste.</i>
	Lack of material handling equipment	W1	<i>The lack of material handling equipment is quite problematic, especially for the traditional markets. We used to double-deck loading for the traditional market shipments to increase efficiency. Yet, we have observed that the unloading times were higher than expected and the rate of products spoil increased. Once we tried to identify the reason for this situation, we learned that most of the traditional markets do not have the handling equipment for double-deck loading and unloading. And during the unloading, employees keep the vehicle's door open to be able to unload. This situation led to an increase in the temperature in the unit and decreased the shelf life of the product.</i>
Inventory-related FLD	Lack of stringent	W1	<i>Traditional markets generally do not have a stringent inventory policy, and most of the time, they calculate their inventory turnover wrong. Thus, they face either shortage of product or excess of product which turns to loss. Since we are aware of these issues, we</i>

inventory
policy

keep tracking traditional markets' order histories. So, if we receive abnormal order amounts or no order for a long time, our system warns us, and we keep in touch with these customers personally and check their orders.

Inaccurate forecasting D3

Inaccurate forecasting and seasonality can lead to food loss. Our daily milk product is generally preferred by our customer group with better socio-economic status. And with the beginning of this summer, this customer group moves from their homes in the city centres to their summer houses. While the demand for this product increases in the summer regions, it decreases in the city centre. If we cannot make the demand estimate correctly, this product, which has a shelf life of three days, remains on the shelf and eventually turns into a loss of food.

Poor order implementation D1

Poor order implementations are one of the drivers of the loss. Sometimes traditional markets order the wrong type of products, and they want to return those products. Except for long-life milk, all other products are transported within a cold regime. We can accept these products if the consumer can resent them to us with ensuring the temperature regime. Otherwise, we can't accept the products. If we don't accept the product and they can't sell on time, product turn to waste.

Resource: Compiled by author

5.2.2.3. Logistics-related critical food loss drivers for meat and poultry supply chain

To identify LCFLDs, a total of fourteen interviews were conducted from identified stakeholder groups. Five of these interviews were conducted with experts from the meat and poultry industry (processors). Four interviews were conducted with retailers. One interview was conducted with a wholesaler. Three interviews were conducted with logistics service providers who transport raw and finished meat and poultry products. One interview was conducted with food security certificate inspector.

Four main drivers are identified which cause food loss in the meat and poultry supply chain based on the literature review and thematic analysis. The identified drivers are transportation-related drivers, warehousing-related drivers, Inventory management -related drivers and packaging-related drivers. Improper transportation conditions, logistics hold-ups, lack of cold chain equipment and poor transportation handling are identified as the sub-drivers of the transportation-related drivers. Three sub-drivers were identified for the warehousing-related drivers, which are improper storage, lack of cold storage infrastructure and poor storage handling. Three sub-drivers were identified as inventory management-related sub-drivers which are lack of stringent inventory policy, inaccurate forecasting and poor order implementation. According to thematic analysis results, packaging-related drivers lead to loss at the meat and poultry supply chain. Three identified sub-drivers were suboptimal use of packaging functions, inappropriate package size and inappropriate secondary packaging. No driver has been identified from communication function. Table 39 shows the identified primary and sub-drivers that cause food loss in the meat and poultry supply chain.

Table 39: Main Drivers and Sub-drivers that cause Food Loss in the Meat and Poultry Supply Chain

Driver	Sub-driver	Participant Code	Quotation
Transport-related FLD	Improper transportation conditions	T2	<i>The export of finished products in the meat and poultry industry increased dramatically in the last couple of years. We export frozen and fresh chicken products to abroad. Fresh products mostly send with air transportation because of the short shelf life. Yet, one of the biggest problems is that in air transportation we don't have reefer containers which are very expensive and not common. Shippers ensure the cold regime with dry ice and thermal blankets. Yet, sometimes these precautions are not enough, especially at high temperatures. This situation ends up with losing the entire batch.</i>
		M3	<i>The livestock is transported to our facility alive. The transportation conditions of the animals are extremely important because if the animal gets stressed, the quality of the meat decrease, and also animals get dehydrated, we face loss even before the processing. If the livestock is loaded to the transportation unit incorrectly, bruises occur on the body of the animal and the quality of the meat decreases. If the percentage of bruises are high, then the animal cannot be processed and has to be destroyed.</i>
	Logistics hold-ups	T4	<i>While exporting fresh products, we have to use air transportation due to shelf life. While handling the export shipment, we use dry ice and thermal blankets. These tools temperature protection changes based on both the temperature level and time spend on apron and land. Thus, if a delay occurs, we have the risk of losing the entire shipment. In fact, approximately within every 15 shipments 1 shipment becomes loss because of the delays.</i>
	Poor transportation handling	M5	<i>After we place each pallet, we need to immobilize pallets so that when the truck makes sudden movements, pallets won't move and products won't get damaged.</i>
		T4	<i>The loadings inside the reefer containers must be on a certain level so that the reefer container continue to cool down. Yet, we often come across with wrong loadings. In those wrong loadings, alarm systems get activated, and we have to open and reload the entire container. If the alarm gets activated while it is located at the port or the transshipment port, we can re-load the reefer.</i>

	Lack of cold chain equipment	T1	<i>But if the alarm gets activated while it is on the ship, we cannot intervene, and most of the time when we open the reefer container on the final port, the whole products inside the containers are spoiled.</i>
Warehousing-related FLD	Improper storage	M2	<i>To export fresh products, we use air transportation. But the refrigerated container for air transportation is very expensive and difficult to find. Thus, we use dry ice and thermal blankets to ensure the cold transportation regime. This method enables the cold regime for an approximate time period. When the flight delays, we face the risk of losing the entire volume.</i>
	Lack of cold storage infrastructure	M1	<i>Our products are packaged with sensitive material. Thus, we do not prefer to put packages on top of another. In our warehouse, we pay the utmost attention to storing. And when our agent distributes it to retail stores and traditional markets, we make the warnings about storage. Yet most of the time we get complaints from our customers about damaged packaging.</i>
		T4	<i>Most of the time, the only storage facility in a retail store is the freezer that is in the store. This means that retail stores do not have additional storage capacity. Therefore, when a surplus situation occurs in the fresh product category, the store must send either back immediately to the distribution centre or us or another store while ensuring the cold chain. Otherwise, products become a loss.</i>
	Poor storage handling	M4	<i>We export frozen chicken products with seaway using reefer containers. We face with food loss when there are not enough plugins for the reefer containers at the transshipment ports.</i>
Inventory planning and controlling-related FLD	Lack of stringent inventory policy	W1	<i>Sometimes forklift knives can prick boxes. Once the package gets damaged or torn apart, we cannot re-work with the products due to the risk of contamination. Thus, these products become a loss.</i>
			<i>Traditional markets don't have stringent inventory policies. Sometimes, these markets order more than the actual demand to get discounts while believing that they can sell the products before their shelf lives finish. Since these facilities do not have enough cold storage units, excess orders spoil and turn into waste. To eliminate this possibility, we have our own order tracking system and follow our customers' order in case of such a thing can happen</i>

	Inaccurate forecasting	M3	<i>Forecasting is generally a problematic issue in the traditional markets. To get a discount, traditional markets order more than they actually need, and most of the time, they do not have enough cold storage facility to preserve the excess products. Although after a while, they want to resend the product, due to the contamination risk, we take the products and destroy them. But we also invoice the loss.</i>
	Poor order implementation	M1	<i>We are experiencing loss due to the poor order implementation specifically due to wrong product ordering. In this case, the products need to be returned to us immediately exactly in the same condition that we have delivered. Once the product arrives at our facility, we run tests for food security, and only if the food is safe to consume, we then re-distribute it.</i>
Packaging-related FLD	Suboptimal use of packaging functions	M2	<i>Because of the delicacy of the packaging material, we face with food loss. Since we use a thin wrapping film during packaging, the package can be torn easily.</i>
	Inappropriate package size	M2	<i>When we process whole chicken, we adjust the machine for a specific size of the chicken and carry out the processing. When a chicken's size does not meet the arranged size, machine processes the chicken based on adjusted settings. Thus, some of the chicken has a long neck and/or thigh. Since the packages are produced for certain size standards, chicken with long neck and thigh does not fit the package and tear the package.</i>
	Inappropriate secondary packaging	M4	<i>After the primary packaging completed, secondary packaging begins. As a secondary package, we use cardboard boxes which are open from the top. Unlike other industries, we cannot put too many secondary boxes on top of each one, and also we cannot stretch them. Thus we need to be extra careful during the whole transportation process.</i>

Resource: Compiled by author

5.2.2.4. Logistics-related critical food loss drivers for fruit and vegetable supply chain

To identify LCFLDs, a total of twenty-three interviews were conducted from identified stakeholder groups. Three of these interviews were conducted with farmers. Ten interviews were conducted with an expert from different fruit and vegetable processors. Four interviews were conducted with retailers; one interview was conducted with a wholesaler. Three interviews were conducted with logistics service providers who transport raw and finished fruit and vegetable products. One interview was conducted with food security certificate inspector. One interview was conducted with a board member of Aegean exporters' association.

Based on the literature review and thematic analysis, three types of LCFLDs are identified for milk and dairy product supply chain. Transportation-related drivers, warehousing-related drivers and inventory management related drivers are identified as the main drivers. Five sub-drivers were identified for the transportation-related drivers. Improper transportation conditions, logistics hold-ups, transportation cost, lack of cold chain equipment and poor transportation handling were the identified sub-drivers of the transportation-related drivers. Five sub-drivers were determined for the warehousing-related drivers according to the literature review and thematic analysis. Lack of storage infrastructure, improper storage, lack of cold storage infrastructure, poor storage handling and lack of material handling equipment are the identified sub-drivers. Lack of stringent inventory policy, inaccurate forecasting and poor order implementation are the sub-drivers that is identified as inventory management related drivers. According to thematic analysis, no driver has been identified from packaging and communication function. Table 40 shows the identified main and sub-drivers, which lead to food loss in the fruit and vegetable supply chain.

Table 40: Main Drivers and Sub-drivers that cause Food Loss in the Fruit and Vegetable Supply Chain

Driver	Sub-driver	Participant Code	Quotation
Transport-related FLD	Improper transportation conditions	FV5	<i>We observed that farmers load the harvested products without any packaging in bulk conditions. During transportation, small and round sized products such as grapes and tomatoes fall from the transportation unit. This improper transportation condition cause 10 percent of the products become a loss.</i>
	Logistics hold-ups	FV10	<i>Right after the harvest, fruits and vegetables start to lose water and nutritional value. As the products wait, the amount of loss also increases.</i>
		FV8	<i>We work with farmers who have a contractual relationship with us. One of the requirements of the contract is that as soon as the farmers complete the harvest, they need to transport the harvested products to our facility. Because as soon as the product is harvested, the loss in terms of nutritional value begins.</i>
	Transportation cost	F2	<i>We select the crops that we are going to plant at the beginning of the year from, based on crops which were earned high-profit margin last year. Most of the farmers also do the same thing. Once the crops supply increases, the buying price decreases. Sometimes, price decreases so much that the money spent on transporting the crops becomes higher than the buying price. In this case, we don't harvest.</i>
	Lack of cold chain equipment	FV4	<i>Right after the harvest, fruits and vegetables start to lose water and nutritional value. As the products wait, the amount of loss also increases. The only way to prevent the loss, in this case, is to transport and store the products within a cold regime. Yet, in Turkey, most of the farmers have neither cold transportation vehicles nor cold storage infrastructures.</i>
	Poor transportation handling	FV6	<i>We produce dried fruits, and our products are extremely sensitive to impacts. We have to make sure that our products are stabilized inside the transportation unit to diminish the risk of impact. In the past, we made a transshipment without stabilizing the pallets inside the transportation unit, and we lost the entire volume inside of the transportation unit.</i>

Warehousing-related FLD	Improper storage	FV9	<i>Food loss mostly occurs during the warehousing stage. Sometimes we have to store seasonal fruits and vegetables 6-7 months. During the storage process, we experience loss in weight or rottenness begins. If the fruits and vegetables are piled up without considering the weight, the products which are located at the under most, rot.</i>
		FV1	<i>We lose some finished products because of improper storing. One group of our product is canned products. If we put too many cans on top of each other, the cans which are at the bottom will be crushed. Due to food security reasons, we cannot sell the crushed cans, and we have to destroy those products.</i>
	Lack of storage infrastructure	FV7	<i>To be able to consume our products within the estimated expiration date, it should be located at dry, non-moist places. Yet, we get complaints from our consumers about spoilage. When we examine the case, we see that retailer did not store our products as it is required. Since they do not have enough storage infrastructure, they keep different types of products together, especially at the retailer's store.</i>
		R4	<i>We have a quite working system in our main warehouses in terms of handling the products, but we fail to enable the same system at every retail store due to the limited space. Thus, we prefer to store products at the display shelves.</i>
	Lack of cold storage infrastructure	FV4	<i>Right after the harvest, fruits and vegetables start to lose water and nutritional value. As the products wait, the amount of loss also increases. The only way to prevent the loss, in this case, is to transport and store the products within a cold regime. Yet, in Turkey, most of the farmers have neither cold transportation vehicles nor cold storage infrastructures.</i>
	Poor storage handling	R3	<i>We handle products at our main warehouses, but we are not capable of handle every product in our retail stores. Thus, big brands that we are working together send their own employee to arrange shelves and handle the products.</i>
	Lack of material handling equipment	FV6	<i>Most of the time, traditional markets do not have enough equipment to complete unloading efficiently. Instead of using machine power, they use human power. The unloading process conducted with using human power increases the temperature of the container increases,</i>

Inventory-related FLD	Lack of stringent inventory policy	FV2	and this situation increases the possibility of contamination and diminishes the shelf life of the perishable products.
			<i>For perishable fruit and vegetable, we directly send the finished products to the retailer's store to increase the shelf life. Yet, we have observed that retailer stores are not good at calculating inventory turnover. In the past, we had a problem with one of a retailer's store because of this. The retailer store calculated the turnover wrong for the tomato, and at the end, the store had to destroy tomato, which was excessively ordered.</i>
	Inaccurate forecasting	F2	<i>I generally, plant whatever crop that I want unless a legally binding contract occurs between a processor and me. Generally, I plant crop which was short in supply last year, because farmers who planted that scarce product last year made good profits. But this strategy is not only followed by me. Other farmers adopt similar strategies, as well. This means that at the end of the harvest period, the product which was scarce last year becomes quite commonly available. So, the buying price of the product decreases. In fact, it decreases so much that some of us even do not harvest the product.</i>
		F3	<i>Bazaars are an important stakeholder in the chain. Sometimes when I harvest my product, instead of selling to a wholesaler, I prefer to sell it at the bazaar. But the demand is very uncertain, and at the end of the day, there is a possibility that I cannot sell the entire volume. Since the products wait on the display without any protection, at the end of the day, I have to throw them since deformity occurs in their shape.</i>
	Poor order implementation	FV3	<i>Especially in the case of faulty orders, the time spent on the road will increase. Products need to be collected and then return to our facility and then re-distribute. In this case, the shelf life of the product decreases and also consumers do not prefer to buy those products as they will begin to wear out.</i>

Resource: Compiled by author

5.2.3. Summary

Both qualitative and quantitative analysis results revealed that there are four logistics-related critical food loss drivers and twenty one logistics-related critical food loss sub-drivers were identified. However, the occurrence of both drivers and sub-drivers change according to FSC type. Table 41 shows the logistics-related critical food loss drivers and sub-drivers for four FSCs.

Table 41: Identified and Classified Logistics-related Critical Food Loss Drivers and Sub-drivers for each Food Supply Chain

Driver	Sub-driver	FO	MDP	MP	FV
Transportation-related drivers	Improper transportation conditions	x		x	x
	Logistics hold-ups		x	x	x
	Transportation cost				x
	Inadequate transportation infrastructure				
	Lack of cold chain equipment	x	x	x	x
	Poor transportation handling	x	x	x	x
	Improper handling equipment	x			
Warehousing-related drivers	Lack of storage infrastructure				x
	Improper storage		x	x	x
	Improper conditions of storage				
	Lack of cold storage infrastructure	x	x	x	x
	Poor storage handling	x	x	x	x
	Inappropriate shelf space	x	x		
	Lack of material handling equipment	x	x		x
	Lack of stringent inventory policy	x	x	x	x

Inventory management - related drivers	Inaccurate forecasting	x	x	x	x
	Poor ordering implementation	x	x	x	x
Packaging-related drivers	Suboptimal use of packaging functions			x	
	Inappropriate package size			x	
	Inappropriate secondary packaging			x	
Communication-related drivers	Lack of communication				

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In Table 41, FO means fats and oil supply chain, MDP means milk and dairy product supply chain, MP means meats and poultry supply chain and FV means fruit and vegetable supply chain. Although in the literature it has been mentioned that especially for the developing countries, inadequate transportation infrastructure is a primary reason for food loss, none of the experts did mention inadequate transportation infrastructure as loss driver for Turkish food supply chains. Thus, in this study, inadequate transportation infrastructure was removed from the analysis. In addition, none of the experts identified improper conditions of storage as a food loss driver for Turkish food supply chains. Thus, improper conditions of storage were also removed from the LCFLDs list. Similarly, none of the interviewees mentioned any problems in terms of lack of communication. Interviewed experts mentioned that communication between members never stops. Moreover, conducted interviews revealed that improper handling equipment causes food loss in the fats and oil supply chain. Similarly, interviews revealed that a sub-driver which is under the packaging-related drivers impact the amount of loss in the meat and poultry industry. Thus, inappropriate secondary packaging was added as a sub-driver.

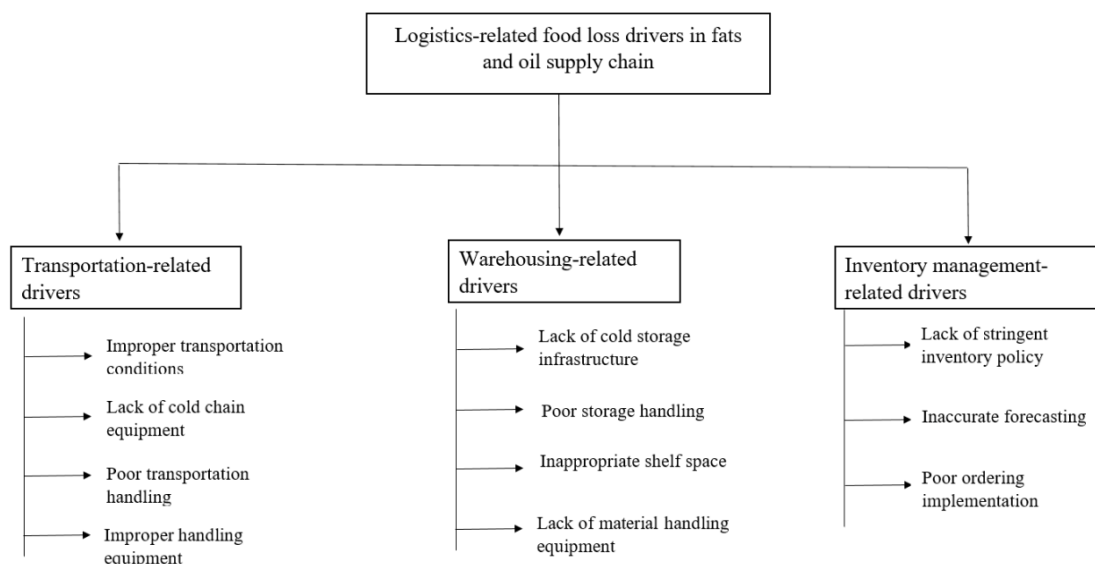
5.3. FINDINGS OF LOGISTICS-RELATED CRITICAL FOOD LOSS DRIVERS PRIORITIZATION

The third objective of the thesis was to rank the logistics-related critical food loss drivers, which have a higher impact on the waste amount, for reducing the overall food loss. For this purpose, the AHP method was applied. For the mathematical calculations, the mathematical formulations, which was explained in chapter 4, was followed. For each type of food supply chain, the different analysis was calculated. The next section shows the result of each food supply chain type.

5.3.1. Prioritization of logistics-related food loss drivers of fats and oil supply chain

After the decision problem and conceptual framework were identified, the next step was forming the decision hierarchy framework. Decision hierarchy framework is illustrated for the fats and oil supply chain in Figure 28.

Figure 28: LCFLDs Decision Hierarchy Framework for Upstream and Midstream Fats and Oil Supply Chain



Resource: Compiled by author

Seven experts completed the AHP questionnaire to rank the LCFLD, which have a higher impact on the waste amount. After collecting each questionnaire, the geometric mean of responses was taken. Based on the geometric mean of the responses, the comparison matrix of the drivers is shown as follows:

$$A = \begin{bmatrix} 1.00 & 1.12 & 3.21 \\ 0.89 & 1.00 & 2.15 \\ 0.31 & 0.47 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.45 & 0.43 & 0.50 \\ 0.41 & 0.39 & 0.34 \\ 0.14 & 0.18 & 0.16 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.46 \\ 0.38 \\ 0.16 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is, which is shown below.

$$A \times w = \begin{bmatrix} 1.40 \\ 1.13 \\ 0.48 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{3.01+3.01+3.00}{3} = 3.01$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{3.01-3}{2} = 0.004597$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.004597}{0.58} = 0.07926$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. Thus, the values in the priority vector are used to rank the criteria according to the impact level. Table 42 shows the ranking of the main LCFLD for the fats and oil supply chain.

Table 42: The Ranking of the Main LCFLD for the Upstream and Midstream Fats and Oil Supply Chain

Main LCFLD	Rank	Weight (percentage)
Transportation-related drivers	1	46,39
Warehousing-related drivers	2	37,66
Inventory management-related drivers	3	15,95

Resource: Compiled by author

Based on the expert opinions and AHP calculations, transportation-related drivers are the drivers which lead to most loss in the fats and oil upstream and midstream supply chain. The second driver which leads to loss in the fats and oil upstream and midstream supply chain is warehousing-related drivers. Last driver is inventory management-related drivers.

After ranking the main LCFLD, the next stage was calculating each sub-drivers' rankings according to the impact level. The transportation-related driver has four sub-drivers which are improper transportation conditions, lack of cold chain

equipment, poor transportation handling and improper handling equipment. Based on the geometric mean of the responses, the comparison matrix for the sub-drivers of transportation is shown as follows:

$$A = \begin{bmatrix} 1.00 & 2.96 & 3.21 & 2.83 \\ 0.34 & 1.00 & 0.93 & 2.45 \\ 0.31 & 1.08 & 1.00 & 1.60 \\ 0.35 & 0.41 & 5.77 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.50 & 0.54 & 0.56 & 0.36 \\ 0.17 & 0.18 & 0.16 & 0.31 \\ 0.16 & 0.20 & 0.17 & 0.20 \\ 0.18 & 0.07 & 0.11 & 0.13 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.49 \\ 0.21 \\ 0.18 \\ 0.12 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is shown below.

$$A \times w = \begin{bmatrix} 2.03 \\ 0.84 \\ 0.75 \\ 0.49 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{4.14+4.07+4.12+4.05}{4} = 4.10$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{4.10 - 4}{3} = 0.03216$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.03216}{0.90} = 0.03573$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. Thus, the values in the priority vector are used to rank the criteria according to the impact level. Table 43 shows the ranking of the transportation-related food loss sub-drivers for the fats and oil supply chain.

Table 43: The Ranking of the Transportation-related Food Loss Sub-drivers for the Upstream and Midstream Fats and Oil Supply Chain

Transportation-related food loss sub-drivers	Rank	Weight (percentage)
Improper transportation	1	48,98
Lack of cold chain equipment	2	20,62
Poor transportation handling	3	18,24
Improper handling equipment	4	12,17

Resource: Compiled by author

According to results of AHP, sub-driver which leads to most of the loss in the fats and oil upstream and midstream supply chain is improper transportation. Second sub-driver, which leads to high amount of food loss, is lack of cold chain equipment. Poor transportation handling and improper handling equipment are the third and fourth sub-drivers.

The warehousing-related driver has four sub-drivers which are lack of cold storage infrastructure, poor storage handling, inappropriate shelf space and lack of material handling equipment. Based on the geometric mean of the responses, the comparison matrix for the sub-drivers of warehousing is shown as follows:

$$A = \begin{bmatrix} 1.00 & 1.59 & 0.63 & 2.83 \\ 0.63 & 1.00 & 1.22 & 5.78 \\ 1.59 & 0.82 & 1.00 & 2.42 \\ 3.57 & 0.17 & 3.26 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.28 & 0.44 & 0.19 & 0.24 \\ 0.18 & 0.28 & 0.37 & 0.48 \\ 0.44 & 0.23 & 0.31 & 0.20 \\ 0.10 & 0.05 & 0.13 & 0.08 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.29 \\ 0.33 \\ 0.30 \\ 0.09 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is shown below.

$$A \times w = \begin{bmatrix} 1.25 \\ 1.38 \\ 1.24 \\ 0.37 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To

calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{4.33+4.23+4.19+4.14}{4} = 4.22$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{4.22 - 4}{3} = 0.07418$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.07418}{0.90} = 0.0824$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. Thus, the values in the priority vector are used to rank the criteria according to the impact level. Table 44 shows the ranking of the warehousing-related food loss sub-drivers for the fats and oil supply chain.

Table 44: The Ranking of the Warehousing-related Food Loss Sub-drivers for the Upstream and Midstream Fats and Oil Supply Chain

Warehousing-related food loss sub-drivers	Rank	Weight (percentage)
Poor storage handling	1	32,74
Inappropriate shelf space	2	29,53
Lack of cold storage infrastructure	3	28,81
Lack of material handling equipment	4	8,93

Resource: Compiled by author

According to AHP results, poor storage handling sub-driver is the first sub-driver which leads to most loss amount in the fats and oil upstream and midstream supply chain, which is followed by inappropriate shelf space. The third sub-driver is

lack of cold storage infrastructure while the last sub-driver is lack of material handling equipment.

Inventory management -related driver have 3 sub-drivers which are lack of stringent inventory policy, inaccurate forecasting and poor order implementation. Based on the geometric mean of the responses, the comparison matrix for the sub-drivers of Inventory management is shown as follows:

$$A = \begin{bmatrix} 1.00 & 0.76 & 1.21 \\ 1.32 & 1.00 & 2.15 \\ 0.83 & 0.47 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.32 & 0.34 & 0.28 \\ 0.42 & 0.45 & 0.49 \\ 0.26 & 0.21 & 0.23 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.31 \\ 0.45 \\ 0.23 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is shown below.

$$A \times w = \begin{bmatrix} 0.94 \\ 1.37 \\ 0.70 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{3.01+3.01+3.01}{3} = 3.01$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{3.01-3}{2} = 0.00502$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.00502}{0.58} = 0.00865$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. In this case, the values in the priority vector are used to rank the criteria according to the impact level. Table 45 shows the ranking of the Inventory management -related food loss sub-drivers for the fats and oil supply chain.

Table 45: The Ranking of the Inventory Management-related Food Loss Sub-drivers for the Upstream and Midstream Fats and Oil Supply Chain

Inventory management -related food loss sub-drivers	Rank	Weight (percentage)
Inaccurate forecasting	1	45,38
Lack of stringent inventory policy	2	31,24
Poor order implementation	3	23,38

Resource: Compiled by author

Inventory management-related sub-driver which leads to most loss in the upstream and midstream supply chain is inaccurate forecasting. The second inventory management-related sub-driver which cause food loss is lack of having a stringent inventory policy and the third sub-driver is poor order implementation. After identifying weights of drivers and sub-drivers of LCFLDs separately, to identify which driver causes the most loss amount, driver and sub-driver weights are multiplied. As a

result of this operation, the following table is prepared to rank the LCFLDs from the sub-driver which cause most loss in the upstream and midstream supply chain to the driver which cause the least loss in the upstream and midstream supply chain. Table 46 shows the overall ranking of the 11 sub-drivers that are listed from the highest to the lowest impact on the loss amount.

Table 46: Overall Ranking for Upstream and Midstream Fats and Oil Supply Chain

Ranking	Driver	Sub-driver	Driver weight	Sub-driver weight	Overall weight
1	Transportation-related driver	Improper transportation	0.4639	0.4898	0.227
2	Warehousing-related driver	Poor storage handling	0.3766	0.3274	0.123
3	Warehousing-related driver	Inappropriate shelf space	0.3766	0.2953	0.112
4	Warehousing-related driver	Lack of cold storage infrastructure	0.3766	0.2881	0.108
5	Transportation-related driver	Lack of cold chain equipment	0.4639	0.2062	0.096
6	Transportation-related driver	Poor transportation handling	0.4639	0.1824	0.085
7	Inventory management - related driver	Inaccurate forecasting	0.1595	0.4538	0.072
8	Transportation-related driver	Improper handling equipment	0.4639	0.1217	0.056
9	Inventory management - related driver	Lack of stringent inventory policy	0.1595	0.3124	0.049
10	Inventory management - related driver	Poor order implementation	0.1595	0.2338	0.037
11	Warehousing-related driver	Lack of material handling equipment	0.3766	0.0893	0.034

Resource: Compiled by author

When the overall ranking table is examined, it is observed that improper transportation is the most prominent LCFLDs which leads to most loss in the upstream and midstream fats and oil supply chain. During the transportation of bulk raw oil and processed bulk oil, the loss occurs if the flexitank is not used. The most amount of loss occurs due to the improper transportation because when the loss occurs it occurs in bulk size. Poor storage handling is the second LCFLD that causes the most losses in the upstream and midstream supply chain. Dropping the pallets or flexitanks while placing into the storage unit and sticking the forklift forks to products instead of pallets are the main reason for poor storage handling. In each case, the package of the product is damaged or broken, so the damaged products need to be re-worked in the refinery or sent to waste management to destroy. Inappropriate shelf space is the third LCFLDs that cause the loss in the upstream and midstream fats and oil supply chain, which affects the packaging of the products, especially in the wholesaler warehouses. When the shelf space is not suitable for the bottled products, wholesalers store these products put on top of each other and which leads to crash in glass bottle products or smash in plastic bottle products. Once the glass bottle is broken it cannot be used or reworked again due to safety reasons. Thus these products need to be destroyed. When the package is damaged due to putting on top of each other, the product can be reworked after being ensured that the product is not contaminated.

Lack of cold storage infrastructure is the fourth LCFLD that cause food loss in the fats and oil upstream and midstream supply chain. Butter and margarine require cool temperature regime while transportation and storage. For this reason, when the cold chain infrastructure is not adequate the products melt and lose its form. Margarine product is formed with mixing different types of oil and if the temperature gets high, the oils dissociate and require reworking. Although in some cases, dissociated products can be still sold, it is still considered as food loss because the nutritious value of the finished product still diminishes. However, in most cases, dissociated products are returned to the refinery and re-worked.

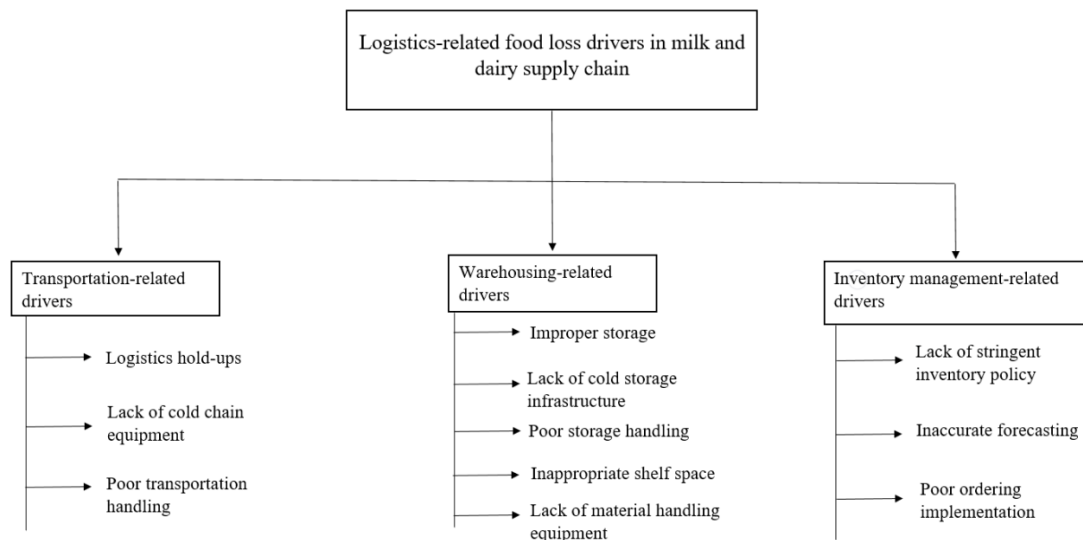
Lack of cold chain equipment is the fifth LCFLD in the upstream and midstream fats and oil supply chain. Not having reefer containers while importing and exporting the products which require cool or cold chain transportation, and not having refrigerated trucks while distributing the finished products lead to food loss. Poor

transportation handling is the sixth LCFLD that leads to food loss in the fats and oil upstream and midstream supply chain. If the products are not stabilized inside the transportation unit, the possibility of getting damaged of the products are quite high. The LCFLD which leads to the least loss is lack of material handling equipment at the upstream and midstream fats and oil supply chain. Since generally corporate or big companies operate in the upstream and midstream supply chain, these firms do not have a problem with having material handling equipment. Thus, this sub-driver has the least impact on the upstream and midstream fats and oil supply chain.

5.3.2. Prioritization of logistics-related food loss drivers of milk and dairy product supply chain

After the decision problem and conceptual framework were identified, the next step was forming the decision hierarchy framework. Decision hierarchy framework is illustrated for the milk and dairy supply chain in Figure 29.

Figure 29: LCFLDs Decision Hierarchy Framework for Upstream and Midstream Milk and Dairy Product Supply Chain



Resource: Compiled by author

Eleven experts completed the AHP questionnaire to rank the LCFLD, which have a higher impact on the waste amount for the milk and dairy products supply chain.

After collecting each questionnaire, the geometric mean of responses was taken. Based on the geometric mean of the responses, the comparison matrix of the drivers is shown as follows:

$$A = \begin{bmatrix} 1.00 & 1.25 & 2.78 \\ 0.80 & 1.00 & 3.86 \\ 0.36 & 0.26 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.46 & 0.50 & 0.36 \\ 0.37 & 0.40 & 0.51 \\ 0.17 & 0.10 & 0.13 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.44 \\ 0.42 \\ 0.13 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is shown below.

$$A \times w = \begin{bmatrix} 1.34 \\ 1.29 \\ 0.40 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{3.04+3.05+3.01}{3} = 3.03$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{3.03-3}{2} = 0.01697$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.01697}{0.58} = 0.02926$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. In this case, the values in the priority vector are used to rank the criteria according to the impact level. Table 47 shows the ranking of the main LCFLD for the milk and milk and dairy products supply chain.

Table 47: The Ranking of the Main LCFLD for the Upstream and Midstream Milk and Dairy Product Supply Chain

Main LCFLD	Rank	Weight (percentage)
Transportation-related drivers	1	44,17
Warehousing-related drivers	2	42,47
Inventory management-related drivers	3	13,36

Resource: Compiled by author

Results of AHP revealed that the driver which leads to the most loss in the milk and dairy supply chain is transportation-related drivers which are followed by warehousing-related drivers. However, when the weights of the main drivers are compared, it is observed that the difference is less than 2 percent. Thus, we can say that transportation-related drivers and warehousing-related drivers almost have the same impact on the loss amount. According to AHP results, inventory management-related drivers lead to the least amount of food loss in the milk and dairy upstream and midstream supply chain.

After ranking the main LCFLD, the next stage was calculating each sub-drivers' rankings according to the impact level. Transportation-related driver has three sub-drivers which are logistics hold-ups, lack of cold chain equipment, and poor transportation handling. Based on the geometric mean of the responses, the comparison matrix for the sub-drivers of transportation is shown as follows:

$$A = \begin{bmatrix} 1.00 & 3.65 & 4.28 \\ 0.27 & 1.00 & 2.21 \\ 0.23 & 0.45 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.66 & 0.72 & 0.57 \\ 0.18 & 0.20 & 0.30 \\ 0.15 & 0.09 & 0.13 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.65 \\ 0.22 \\ 0.13 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is shown below.

$$A \times w = \begin{bmatrix} 2.01 \\ 0.68 \\ 0.38 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{3.09+3.03+3.02}{3} = 3.05$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{3.05-3}{2} = 0.0225$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.0225}{0.58} = 0.0389$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. In this case, the values in the priority vector are used to rank the criteria according to the impact level. Table 48 shows the ranking of the transportation-related food loss sub-drivers for the milk and dairy products supply chain.

Table 48: The Ranking of the Transportation-related Food Loss Sub-drivers for the Upstream and Midstream Milk and Dairy Product Supply Chain

Transportation-related food loss sub-drivers	Rank	Weight (percentage)
Logistics hold-ups	1	65,00
Lack of cold chain equipment	2	22,43
Poor transportation handling	3	12,57

Resource: Compiled by author

According to industry experts, the main transportation-related food loss driver, which leads to the most loss in the milk and dairy supply chain, is logistics hold-ups. Lack of cold chain equipment is the second transportation-related sub-driver which leads to a loss in the milk and dairy supply chain. Poor transportation handling is the third transportation-related food loss driver which affects the food loss amount least.

The warehousing-related driver has five sub-drivers which are improper storage, lack of cold storage infrastructure, poor storage handling, inappropriate shelf space and lack of material handling equipment. Based on the geometric mean of the responses, the comparison matrix for the sub-drivers of warehousing is shown as follows:

$$A = \begin{bmatrix} 1.00 & 0.85 & 2.65 & 1.12 & 1.14 \\ 1.18 & 1.00 & 1.05 & 2.20 & 3.86 \\ 0.38 & 0.95 & 1.00 & 2.00 & 2.26 \\ 0.89 & 0.45 & 0.50 & 1.00 & 2.45 \\ 0.88 & 0.26 & 0.44 & 0.41 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.23 & 0.24 & 0.47 & 0.17 & 0.11 \\ 0.27 & 0.28 & 0.19 & 0.33 & 0.36 \\ 0.09 & 0.27 & 0.18 & 0.30 & 0.21 \\ 0.21 & 0.13 & 0.09 & 0.15 & 0.23 \\ 0.20 & 0.07 & 0.08 & 0.06 & 0.09 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.24 \\ 0.29 \\ 0.21 \\ 0.16 \\ 0.10 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is shown below.

$$A \times w = \begin{bmatrix} 1.33 \\ 1.54 \\ 1.12 \\ 0.86 \\ 0.55 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{5.49+5.37+5.38+5.37+5.37}{5} = 5.40$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{5.40-5}{4} = 0.09959$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.09959}{1.12} = 0.08892$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. In this case, the values in the priority vector are used to rank the criteria according to the impact level. Table 49 shows the ranking of the warehousing-related food loss sub-drivers for the milk and dairy products supply chain.

Table 49: The Ranking of the Warehousing-related Food Loss Sub-drivers for the Upstream and Midstream Milk and Dairy Product Supply Chain

Warehousing-related food loss sub-drivers	Rank	Weight (percentage)
Lack of cold storage infrastructure	1	28,60
Improper storage	2	24,31
Poor storage handling	3	20,87
Inappropriate shelf space	4	16,04
Lack of material handling equipment	5	10,18

Resource: Compiled by author

According to industry experts, the main warehousing-related food loss driver, which leads to the most loss in the milk and dairy supply chain, is lack of cold storage infrastructure. Improper storage is the second warehousing-related sub-driver which leads to a loss in the milk and dairy supply chain. Poor storage handling is the third warehousing-related food loss driver which is followed by inappropriate shelf space. Lack of material handling equipment is the last warehousing-related driver which affects food loss amount least.

Inventory management-related driver has three sub-drivers which are lack of stringent inventory policy, inaccurate forecasting and poor order implementation. Based on the geometric mean of the responses, the comparison matrix for the sub-drivers of Inventory management is shown as follows:

$$A = \begin{bmatrix} 1.00 & 1.25 & 1.10 \\ 0.80 & 1.00 & 1.15 \\ 0.91 & 0.87 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.37 & 0.40 & 0.34 \\ 0.30 & 0.32 & 0.35 \\ 0.34 & 0.28 & 0.31 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.37 \\ 0.32 \\ 0.31 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is shown below.

$$A \times w = \begin{bmatrix} 1.11 \\ 0.97 \\ 0.92 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{3.01+3.01+3.01}{3} = 3.01$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{3.01-3}{2} = 0.005$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.025}{0.58} = 0.00862$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. In this case, the values in the priority vector are used to rank the criteria according to the impact level. Table 50 shows the ranking of the Inventory management -related food loss sub-drivers for the milk and dairy products supply chain.

Table 50: The Ranking of the Inventory Management-related Food Loss Sub-drivers for the Upstream and Midstream Milk and Dairy Product Supply Chain

Inventory management-related food loss sub-drivers	Rank	Weight (percentage)
Lack of stringent inventory policy	1	36,94
Inaccurate forecasting	2	32,32
Poor order implementation	3	30,73

Resource: Compiled by author

According to industry experts, lack of stringent inventory policy is the sub-driver which leads to the most loss amount in the milk and dairy supply chain. Inaccurate forecasting is ranked as the second sub-driver that leads to the most loss in the and poor order implementation is ranked as the third sub-driver which leads to loss in the milk and dairy upstream and midstream supply chain. After identifying weights of drivers and sub-drivers of LCFLDs separately, to identify which driver causes the most loss amount, driver and sub-driver weights are multiplied. As a result of this operation, the following table is prepared to rank the LCFLDs from the sub-driver which cause most loss in the upstream and midstream supply chain to the driver which cause the least loss in the upstream and midstream supply chain. Table 51 shows the overall ranking of the 13 sub-drivers that are listed from the highest to the lowest impact on the loss amount.

Table 51: Overall Ranking for Upstream and Midstream Milk and Dairy Product Supply Chain

Ranking	Driver	Sub-driver	Driver weight	Sub-driver weight	Overall weight
1	Transportation-related driver	Logistics hold-ups	0.4417	0.65	0.2871
2	Warehousing-related driver	Lack of cold storage infrastructure	0.4247	0.286	0.1215
3	Warehousing-related driver	Improper storage	0.4247	0.2431	0.1032
4	Transportation-related driver	Lack of cold chain equipment	0.4417	0.2243	0.0990
5	Warehousing-related driver	Poor storage handling	0.4247	0.2087	0.0886
6	Warehousing-related driver	Inappropriate shelf space	0.4247	0.1604	0.0681
7	Transportation-related driver	Poor transportation handling	0.4417	0.1257	0.0555

8	Inventory management - related driver	Lack of stringent inventory policy	0.1336	0.3694	0.0493
9	Warehousing-related driver	Lack of material handling equipment	0.4247	0.1018	0.0432
10	Inventory management - related driver	Inaccurate forecasting	0.1336	0.3232	0.0431
11	Inventory management - related driver	Poor order implementation	0.1336	0.3073	0.0410

Resource: Compiled by author

When the overall ranking table is examined, it is observed that logistics hold-ups are the most prominent LCFLDs which leads to the most loss in the upstream and midstream milk and dairy supply chain. The raw milk needs to be processed within 48 hours. So, if there is a delay occurs at the delivery of the raw milk, the possibility of spoilage of the raw milk increases. Lack of cold storage infrastructure is the second LCFLD that leads to a loss in the upstream and midstream milk and dairy product supply chain. Except for UHT milk, daily milk and dairy products need to be stored in cool temperature regime. When there is not enough cold storage place, this situation leads to loss. The products which left out outside of the cold storage will be spoiled. Due to food safety reasons, products cannot be consumed on time and they needed to be destroyed. Improper storage is the third LCFLDs that lead to the loss in the upstream and midstream milk and dairy supply chain. Especially, when the products are put on top of each other, this storing causes damage to the package such as leakage on the packages or crushes. Since consumers have strict appearance requests about the food products, these damaged packaging products cannot be sold and eventually they turn into waste (de Hooge et al., 2017).

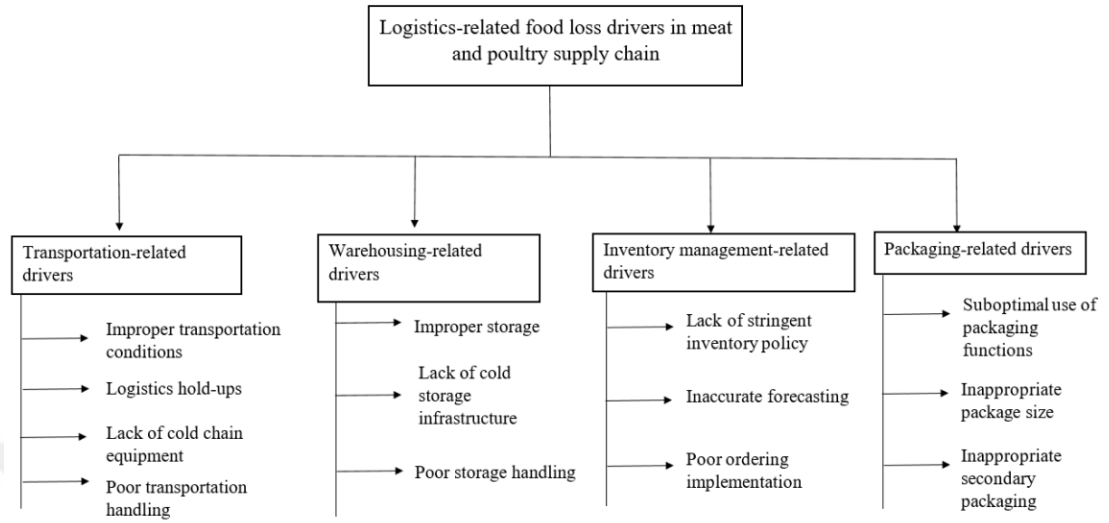
Lack of cold chain equipment is the fourth LCFLD that leads to the loss in the upstream and midstream supply chain. While distributing the finished products, the lack of cold chain equipment can lead to a loss in several ways. First of all, during the export process, products need to be transferred with reefer containers. Breaking the

cold temperature chain because of the lack of cold chain equipment causes the loss since the product will grow bacteria and get contaminated. Similar to export, during local distributions if the LSPs do not have enough number of refrigerated trucks or if they do not open the cooler to economize fuel cost especially for close distribution points, these situation cause loss. Poor storage handling is the fifth LCFLD that cause loss in the upstream and midstream supply chain. Especially, accidents occurred during loading and unloading the storage units cause loss. Dropping pallets or sticking the forklift knives to products also cause loss at the warehouses. The LCFLD which leads to the least loss is poor order implementation at the upstream and midstream milk and dairy product supply chain. This is an expected result because, in the upstream and midstream supply chain, companies and organizations use advanced order tracking systems which enables them to track the orders generally. Thus, when there is an abnormal order movement, the system automatically warns them and they can get in contact with the party who made the order.

5.3.3. Prioritization of logistics-related food loss drivers of meat and poultry supply chain

After the decision problem and conceptual framework were identified, the next step was forming the decision hierarchy framework. Decision hierarchy framework is illustrated for the meat and poultry supply chain in Figure 30.

Figure 30: LCFLDs Decision Hierarchy Framework for Upstream and Midstream Meat and Poultry Supply Chain



Resource: Compiled by author

Fourteen experts completed the AHP questionnaire to rank the LCFLD, which have a higher impact on the waste amount for the meat and poultry supply chain. After collecting each questionnaire, the geometric mean of responses was taken. Based on the geometric mean of the responses, the comparison matrix of the drivers is shown as follows:

$$A = \begin{bmatrix} 1.00 & 0.20 & 0.18 & 0.90 \\ 5.00 & 1.00 & 1.24 & 2.30 \\ 5.56 & 0.81 & 1.00 & 1.17 \\ 1.11 & 0.43 & 0.85 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.08 & 0.08 & 0.05 & 0.17 \\ 0.39 & 0.41 & 0.38 & 0.43 \\ 0.44 & 0.33 & 0.31 & 0.22 \\ 0.09 & 0.18 & 0.26 & 0.19 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.10 \\ 0.40 \\ 0.32 \\ 0.18 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is shown below.

$$A \times w = \begin{bmatrix} 0.40 \\ 1.69 \\ 1.39 \\ 0.74 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{4.12+4.20+4.30+4.13}{4} = 4.19$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{4.19-4}{3} = 0.06262$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.06262}{0.90} = 0.06958$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. In this case, the values in the priority vector are used to rank the criteria according to the impact level. Table 52 shows the ranking of the main LCFLD for the meat and poultry supply chain.

Table 52: The Ranking of the Main LCFLD for the Upstream and Midstream Meat and Poultry Supply Chain

Main LCFLD	Rank	Weight (percentage)
Warehousing-related drivers	1	40,28
Inventory management-related drivers	2	32,30
Packaging-related drivers	3	17,83
Transportation-related drivers	4	9,59

Resource: Compiled by author

According to expert evaluations, most of the loss occurs because of the warehousing-related drivers in the upstream and midstream of the meat and poultry supply chain. The second main driver which leads to loss in the meat and poultry supply chain is inventory management-related drivers. Third driver which cause the loss in the upstream and midstream meat and poultry supply chain is packaging-related drivers and transportation-related drivers are the fourth driver.

After ranking the main LCFLD, the next stage was calculating each sub-drivers' rankings according to the impact level. The transportation-related driver has four sub-drivers which are improper transportation conditions, logistics hold-ups, poor transportation handling and lack of cold chain equipment. Based on the geometric mean of the responses, the comparison matrix for the sub-drivers of transportation is shown as follows:

$$A = \begin{bmatrix} 1.00 & 1.28 & 1.05 & 0.78 \\ 0.78 & 1.00 & 1.22 & 0.50 \\ 0.95 & 0.82 & 1.00 & 1.65 \\ 1.28 & 2.00 & 0.61 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.25 & 0.25 & 0.27 & 0.20 \\ 0.19 & 0.20 & 0.31 & 0.13 \\ 0.24 & 0.16 & 0.26 & 0.42 \\ 0.32 & 0.39 & 0.16 & 0.25 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.24 \\ 0.13 \\ 0.27 \\ 0.28 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is shown below.

$$A \times w = \begin{bmatrix} 1.01 \\ 0.87 \\ 1.13 \\ 1.17 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{4.17 + 4.16 + 4.21 + 4.17}{4} = 4.18$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{4.18 - 4}{3} = 0.05946$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.05946}{0.90} = 0.06607$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. In this case, the values in the priority vector are used to rank the criteria according to the impact level. Table 53 shows the ranking of the transportation-related food loss sub-drivers for the meat and poultry supply chain.

Table 53: The Ranking of the Transportation-related Food Loss Sub-drivers for the Upstream and Midstream Meat and Poultry Supply Chain

Transportation-related food loss sub-drivers	Rank	Weight (percentage)
Lack of cold chain equipment	1	28,06
Poor transportation handling	2	26,89
Improper transportation conditions	3	24,23
Logistics hold-ups	4	20,82

Resource: Compiled by author

According to expert opinions, lack of cold chain equipment is the first sub-driver of the transportation-related drivers that lead to loss in the upstream and midstream meat and poultry supply chain. Poor transportation handling is the second sub-driver of transportation-related drivers that lead to loss, which is followed by the third sub-driver which is improper transportation conditions. The fourth transportation-related sub driver is logistics hold-ups that lead to loss in the upstream and midstream of the meat and poultry supply chain.

The warehousing-related driver has three sub-drivers which are improper storage, lack of cold storage infrastructure, and poor storage handling. Based on the geometric mean of the responses, the comparison matrix for the sub-drivers of warehousing is shown as follows:

$$A = \begin{bmatrix} 1.00 & 1.89 & 3.85 \\ 0.53 & 1.00 & 2.93 \\ 0.26 & 0.34 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.56 & 0.58 & 0.49 \\ 0.30 & 0.31 & 0.38 \\ 0.15 & 0.11 & 0.13 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.55 \\ 0.33 \\ 0.13 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is which is shown below.

$$A \times w = \begin{bmatrix} 1.65 \\ 0.99 \\ 0.38 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{3.02+3.02+3.01}{3} = 3.01$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{3.01-3}{2} = 0.005$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.005}{0.58} = 0.0086$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. In this case, the values in the priority vector are used to rank the criteria according to the impact level. Table 54 shows the ranking of the warehousing-related food loss sub-drivers for the meat and poultry supply chain.

Table 54: The Ranking of the Warehousing-related Food Loss Sub-drivers for the Upstream and Midstream Meat and Poultry Supply Chain

Warehousing-related food loss sub-drivers	Rank	Weight (percentage)
Improper storage	1	54,63
Lack of cold storage infrastructure	2	32,73
Poor storage handling	3	12,65

Resource: Compiled by author

According to industry experts, the main warehousing-related food loss driver, which leads to the most loss in the meat and poultry supply chain, is improper storage. Lack of cold storage is the second transportation-related sub-driver which leads to a loss in the poultry and meat supply chain. Poor storage handling is the third warehousing-related food loss driver which affects the food loss amount least.

Inventory management-related driver has three sub-drivers which are lack of stringent inventory policy, inaccurate forecasting and poor order implementation. Based on the geometric mean of the responses, the comparison matrix for the sub-drivers of inventory management is shown as follows:

$$A = \begin{bmatrix} 1.00 & 2.45 & 1.02 \\ 0.41 & 1.00 & 1.12 \\ 0.98 & 0.89 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.42 & 0.56 & 0.32 \\ 0.17 & 0.23 & 0.36 \\ 0.41 & 0.21 & 0.32 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.44 \\ 0.25 \\ 0.31 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is shown below.

$$A \times w = \begin{bmatrix} 1.37 \\ 0.78 \\ 0.96 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{3.15+3.09+3.10}{3} = 3.11$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{3.11-3}{2} = 0.055$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.055}{0.58} = 0.0949$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. In this case, the values in the priority vector are used to rank the criteria according to the impact level. Table 55 shows the ranking of the Inventory management -related food loss sub-drivers for the meat and poultry supply chain.

Table 55: The Ranking of the Inventory Management-related Food Loss Sub-drivers for the Upstream and Midstream Meat and Poultry Supply Chain

Inventory management -related food loss sub-drivers	Rank	Weight (percentage)
Lack of stringent inventory policy	1	43,59
Poor order implementation	2	31,15
Inaccurate forecasting	3	25,26

Resource: Compiled by author

According to industry experts, the main inventory management-related food loss driver, which leads to the most loss in the meat and poultry supply chain, is lack of stringent inventory policy. Poor order implementation is the second inventory management-related sub-driver which leads to a loss in the meat and poultry supply chain. Inaccurate forecasting is the third inventory management-related food loss driver which affects the food loss amount least.

The packaging-related driver has three sub-drivers which are suboptimal use of packaging functions, inappropriate package size and inappropriate secondary packaging. Based on the geometric mean of the responses, the comparison matrix for the sub-drivers of inventory management is shown as follows:

$$A = \begin{bmatrix} 1.00 & 0.60 & 3.25 \\ 1.67 & 1.00 & 2.20 \\ 0.31 & 0.45 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.34 & 0.29 & 0.50 \\ 0.56 & 0.49 & 0.34 \\ 0.10 & 0.22 & 0.16 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.38 \\ 0.46 \\ 0.16 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is shown below.

$$A \times w = \begin{bmatrix} 1.17 \\ 1.44 \\ 0.49 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{3.11+3.12+3.04}{3} = 3.09$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{3.09-3}{2} = 0.0456$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.0456}{0.58} = 0.0787$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. In this case, the values in the priority vector are used to rank the criteria according to the impact level. Table 56 shows the ranking of the packaging-related food loss sub-drivers for the meat and poultry supply chain.

Table 56: The Ranking of the Packaging-related Food Loss Sub-drivers for the Upstream and Midstream Meat and Poultry Supply Chain

Packaging-related food loss sub-drivers	Rank	Weight (percentage)
Inappropriate package size	1	46,74
Suboptimal use of packaging functions	2	37,74
Inappropriate secondary packaging	3	15,99

Resource: Compiled by author

According to industry experts, the main packaging-related food loss driver, which leads to the most loss in the meat and poultry supply chain, is inappropriate package size. Suboptimal use of packaging functions is the second packaging-related sub-driver which leads to a loss in the meat and poultry supply chain. Inappropriate secondary packaging is the third packaging-related food loss driver which affects the food loss amount least. Table 57 shows the overall ranking of the 13 LCFLDs that are listed from the highest to the lowest impact on the loss amount in the upstream and midstream meat and poultry supply chain.

Table 57: Overall Ranking for Upstream and Midstream Meat and Poultry Supply Chain

Ranking	Driver	Sub-driver	Driver weight	Sub-driver weight	Overall weight
1	Warehousing-related driver	Improper storage	0.4028	0.5463	0.220
2	Inventory management - related driver	Lack of stringent inventory policy	0.323	0.4359	0.141
3	Warehousing-related driver	Lack of cold storage infrastructure	0.4028	0.3273	0.132
4	Inventory management - related driver	Poor order implementation	0.323	0.3115	0.101
5	Packaging-related driver	Inappropriate package size	0.1783	0.4674	0.083
6	Inventory management - related driver	Inaccurate forecasting	0.323	0.2526	0.081
7	Packaging-related driver	Suboptimal use of packaging functions	0.1783	0.3774	0.067
8	Warehousing-related driver	Poor storage handling	0.4028	0.1265	0.051
9	Packaging-related driver	Inappropriate secondary packaging	0.1783	0.1599	0.029
10	Transportation-related driver	Lack of cold chain equipment	0.0959	0.2806	0.027
11	Transportation-related driver	Poor transportation handling	0.0959	0.2689	0.026
12	Transportation-related driver	Improper transportation conditions	0.0959	0.2423	0.023
13	Transportation-related driver	Logistics hold-ups	0.0959	0.2082	0.019

Resource: Compiled by author

When the overall ranking table is examined, improper storage is the most prominent LCFLD which leads to the most loss in the upstream and midstream meat and poultry supply chain. The packaging of the meat and poultry and especially poultry product is relatively delicate for impact and weights. When the products are stored improperly, the packaging of the products can be damaged in easily. Lack of stringent inventory policy is the second LCFLD that leads to the loss in the upstream and midstream meat and poultry supply chain. Most of the meat and poultry products have short shelf life mainly less than a week. So, especially when the firms do not have regular and stringent inventory policies, this leads to loss for the companies in the upstream and midstream supply chain. Because, in most case companies in the downstream try to buy more or order more product than actually they can sell to get discount, so when they cannot sell the products on the time, they ask the producer or agents to relocate the product. Since the bacteria can grow easily on meat and poultry product when the cold temperature chain breaks, the producer has to ensure that product does not contaminated, which also requires extra time. During all these processes, the shelf life of the product can pass and in this case, producer either has to determinate or freeze the product.

Poor order implementation is the fourth LCFLD that cause loss. Especially wrong product ordering is the main reason for this driver. Although the wrong products are collected immediately, before redistribution, products have to return the processor and needs to be tested for contamination. This is a long process for a product with a shelf life of approximately 5 days. Thus, in this case, most of the time products have to be destroyed. Inappropriate package size is the fifth LCFLD that lead to a loss in the upstream and midstream meat and poultry supply chain. The package size becomes a problem, especially for the whole chicken products. Although the chickens are separated according to their sizes, in the same size range, the size of the whole chicken can vary. In these cases, when the different sized whole chicken is put into the packages, they tear the package. Since the damaged packaging are not preferred by the consumers, the product becomes waste. Inaccurate forecasting is the fifth LCFLD. Because companies forecast their sales at the beginning of the fiscal year and once they plan and contract with their supplier for throughout the year, it is difficult for companies to adjust production plans. Suboptimal use of packaging functions is the

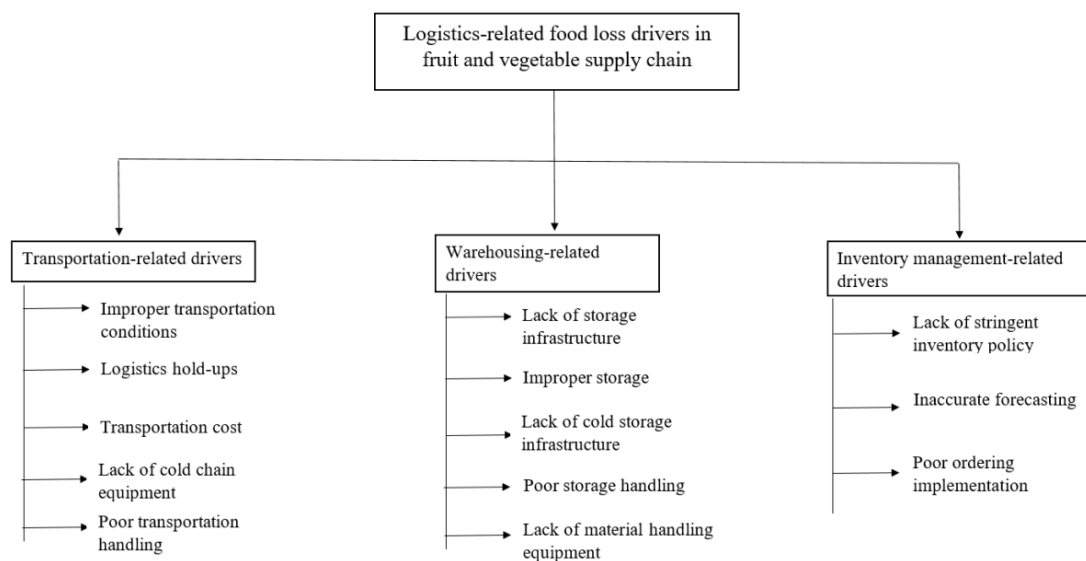
sixth LCFLD which leads to loss in the upstream and midstream supply chain. Using delicate packaging material makes the finished product to more vulnerable to impacts.

Lack of cold storage infrastructure is the third LCFLD that leads to the loss in the upstream and midstream meat and poultry supply chain. The finished meat and poultry products need to be stored in cold or cool temperature regime. So, if there is not enough cold storage infrastructure, the product can grow bacteria and becomes unsuitable for human consumption. The LCFLD which leads to the least loss is logistic hold-ups at the upstream and midstream meat and poultry supply chain. This is an expected result because, animals are delivered while they are still alive so, there will be gradually less loss.

5.3.4. Prioritization of logistics-related food loss drivers of fruit and vegetable supply chain

After the decision problem and conceptual framework were identified, the next step was forming the decision hierarchy framework. Decision hierarchy framework is illustrated for the fruit and vegetable supply chain in Figure 31.

Figure 31: LCFLDs Decision Hierarchy Framework for Upstream and Midstream Fruit and Vegetable Supply Chain



Resource: Compiled by author

Nineteen experts completed the AHP questionnaire to rank the LCFLD, which have a higher impact on the waste amount for the fruit and vegetable supply chain. After collecting each questionnaire, the geometric mean of responses was taken. Based on the geometric mean of the responses, the comparison matrix of the drivers is shown as follows:

$$A = \begin{bmatrix} 1.00 & 0.80 & 1.45 \\ 1.25 & 1.00 & 4.63 \\ 0.69 & 0.22 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.34 & 0.40 & 0.20 \\ 0.43 & 0.50 & 0.65 \\ 0.23 & 0.11 & 0.14 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.31 \\ 0.53 \\ 0.16 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is shown below.

$$A \times w = \begin{bmatrix} 0.97 \\ 1.66 \\ 0.49 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{3.08+3.17+3.05}{3} = 3.10$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{3.10-3}{2} = 0.05$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.05}{0.58} = 0.086$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. In this case, the values in the priority vector are used to rank the criteria according to the impact level. Table 58 shows the ranking of the main LCFLD for the fruit and vegetable supply chain.

Table 58: The Ranking of the Main LCFLD for the Upstream and Midstream Fruit and Vegetable Supply Chain

Main LCFLD	Rank	Weight (percentage)
Warehousing-related drivers	1	52,51
Transportation-related drivers	2	31,39
Inventory management-related drivers	3	16,10

Resource: Compiled by author

Based on the expert opinions and AHP calculations, warehousing-related drivers are the drivers which lead to most loss in the fruit and vegetable upstream and midstream supply chain. The second driver which leads to loss in the fruit and vegetable upstream and midstream supply chain is transportation-related drivers. Last driver is inventory management-related drivers.

After ranking the main LCFLD, the next stage was calculating each sub-drivers' rankings according to the impact level. Transportation-related driver have 5 sub-drivers which are improper transportation conditions, logistics hold-ups, transportation cost, lack of cold chain equipment, and poor transportation handling. Based on the geometric mean of the responses, the comparison matrix for the sub-drivers of transportation is shown as follows:

$$A = \begin{bmatrix} 1.00 & 1.25 & 3.85 & 1.75 & 1.12 \\ 0.80 & 1.00 & 1.85 & 3.75 & 1.96 \\ 0.26 & 0.54 & 1.00 & 0.90 & 0.76 \\ 0.57 & 0.27 & 1.11 & 1.00 & 1.96 \\ 0.89 & 0.51 & 1.32 & 0.51 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.28 & 0.35 & 0.42 & 0.22 & 0.16 \\ 0.23 & 0.28 & 0.20 & 0.47 & 0.29 \\ 0.07 & 0.15 & 0.11 & 0.11 & 0.11 \\ 0.16 & 0.07 & 0.12 & 0.13 & 0.29 \\ 0.25 & 0.14 & 0.14 & 0.06 & 0.15 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.29 \\ 0.29 \\ 0.11 \\ 0.15 \\ 0.15 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is shown below.

$$A \times w = \begin{bmatrix} 1.53 \\ 1.61 \\ 0.60 \\ 0.82 \\ 0.78 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{5.30+5.46+5.35+5.28+5.22}{5} = 5.32$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{5.32-5}{4} = 0.08$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.08}{1.12} = 0.0716$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. In this case, the values in the priority vector are used to rank the criteria according to the impact level. Table 59 shows the ranking of the transportation-related food loss sub-drivers for the milk and dairy products supply chain.

Table 59: The Ranking of the Transportation-related Food Loss Sub-drivers for the Upstream and Midstream Fruit and Vegetable Supply Chain

Transportation-related food loss sub-drivers	Rank	Weight (percentage)
Logistics hold-ups	1	29,45
Improper transportation conditions	2	28,84
Lack of cold chain equipment	3	15,47
Poor transportation handling	4	15,04
Transportation cost	5	11,21

Resource: Compiled by author

According to expert opinions, logistics hold-ups is the first sub-driver of the transportation-related drivers that lead to loss in the upstream and midstream fruit and vegetable supply chain. Improper transportation conditions is the second sub-driver of transportation-related drivers that lead to loss, which is followed by the third sub-driver which is lack of cold chain equipment. The fourth transportation-related sub-driver is poor transportation handling that lead to loss in the upstream and midstream of the meat and poultry supply chain. The last transportation-related sub-driver which leads to least loss in the upstream and midstream supply chain is the transportation cost.

The warehousing-related driver has five sub-drivers which are improper storage, lack of cold storage infrastructure, lack of cold storage infrastructure, poor storage handling and lack of material handling equipment. Based on the geometric mean of the responses, the comparison matrix for the sub-drivers of warehousing is shown as follows:

$$A = \begin{bmatrix} 1.00 & 0.50 & 0.69 & 1.23 & 0.50 \\ 2.00 & 1.00 & 1.13 & 2.75 & 1.74 \\ 1.45 & 0.88 & 1.00 & 0.35 & 0.76 \\ 0.81 & 0.36 & 2.86 & 1.00 & 0.90 \\ 2.00 & 0.57 & 1.32 & 1.11 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.14 & 0.15 & 0.10 & 0.19 & 0.10 \\ 0.28 & 0.30 & 0.16 & 0.43 & 0.36 \\ 0.20 & 0.27 & 0.14 & 0.05 & 0.16 \\ 0.11 & 0.11 & 0.41 & 0.16 & 0.18 \\ 0.28 & 0.17 & 0.19 & 0.17 & 0.20 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.14 \\ 0.30 \\ 0.16 \\ 0.19 \\ 0.20 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is shown below.

$$A \times w = \begin{bmatrix} 0.74 \\ 1.65 \\ 0.85 \\ 1.06 \\ 1.08 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{5.45 + 5.42 + 5.20 + 5.50 + 5.33}{5} = 5.38$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{5.38 - 5}{4} = 0.095$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.095}{1.12} = 0.0848$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. In this case, the values in the priority vector are used to rank the criteria according to the impact level. Table 60 shows the ranking of the warehousing-related food loss sub-drivers for the fruit and vegetable supply chain.

Table 60: The Ranking of the Warehousing-related Food Loss Sub-drivers for the Upstream and Midstream Fruit and Vegetable Supply Chain

Warehousing-related food loss sub-drivers	Rank	Weight (percentage)
Lack of storage infrastructure	1	30,40
Lack of material handling equipment	2	20,26
Poor storage handling	3	19,38
Lack of cold storage infrastructure	4	16,37
Improper storage	5	13,60

Resource: Compiled by author

According to expert opinions, lack of storage infrastructure is the first sub-driver of the warehousing-related drivers that lead to loss in the upstream and midstream fruit and vegetable supply chain. Lack of material handling equipment is the second sub-driver of warehousing-related drivers that lead to loss, which is followed by the third sub-driver which is poor storage handling. The fourth warehousing-related sub driver is lack of cold storage infrastructure that lead to loss in the upstream and midstream of the meat and poultry supply chain. The warehousing-related sub-driver which least impact the food loss amount is improper storage.

Inventory management-related driver has three sub-drivers which are lack of stringent inventory policy, inaccurate forecasting and poor order implementation.

Based on the geometric mean of the responses, the comparison matrix for the sub-drivers of Inventory management is shown as follows:

$$A = \begin{bmatrix} 1.00 & 0.20 & 1.50 \\ 5.00 & 1.00 & 3.35 \\ 0.67 & 0.30 & 1.00 \end{bmatrix}$$

Based on the formula 2, which is given in the mathematical notation section, the calculated normalized matrix is shown as follows:

$$W = \begin{bmatrix} 0.15 & 0.13 & 0.26 \\ 0.75 & 0.67 & 0.57 \\ 0.10 & 0.20 & 0.17 \end{bmatrix}$$

The third step is calculating the priority vector. The priority vector is calculated as the weighted average of each row in the normalized matrix. Priority vector is:

$$w = \begin{bmatrix} 0.18 \\ 0.66 \\ 0.16 \end{bmatrix}$$

The all priority matrix is calculated using formula 3, which is explained in the mathematical notation section. The all priority matrix is shown below.

$$A \times w = \begin{bmatrix} 0.55 \\ 2.09 \\ 0.47 \end{bmatrix}$$

To test the consistency, consistency ratio (CR) needs to be calculated. However, to be able to calculate CR, first λ_{maks} , and CI needs to be calculated. To calculate λ_{maks} , each value in the all priority matrix is divided into each priority vector value, and then the gets averaged. The formulation is shown below.

$$\lambda_{maks} = \frac{3.04+3.15+3.03}{3} = 3.07$$

After calculating λ_{maks} , CI is calculated with applying formula 5, which is explained in section 6.4.2.2. The formulation is shown below.

$$CI = \frac{3.07-3}{2} = 0.0367$$

After calculating CI, CR is calculated with using the formula 6. In this formula, the value of RI is found in Table 13. CR is

$$CR = \frac{0.0367}{0.58} = 0.0633$$

Since CR is lower than 0.1, the experts' responses are considered as consistent. In this case, the values in the priority vector are used to rank the criteria according to the impact level. Table 61 shows the ranking of the Inventory management -related food loss sub-drivers for the fruit and vegetable supply chain.

Table 61: The Ranking of the Inventory Management-related Food Loss Sub-drivers for the Upstream and Midstream Fruit and Vegetable Supply Chain

Inventory management-related food loss sub-drivers	Rank	Weight (percentage)
Inaccurate forecasting	1	66,33
Lack of stringent inventory policy	2	18,00
Poor order implementation	3	15,67

Resource: Compiled by author

According to expert opinions, inaccurate forecasting is the first sub-driver of the inventory management-related drivers that lead to loss in the upstream and midstream meat and poultry supply chain. Lack of stringent inventory policy is the second sub-driver of inventory management-related drivers that lead to loss, which is followed by the third sub-driver which is poor order implementation. Table 62 shows the overall ranking of the 13 sub-drivers that are listed from the highest to the lowest impact on the loss amount.

Table 62: Overall Ranking for Upstream and Midstream Fruit and Vegetable Supply Chain

Ranking	Driver	Sub-driver	Driver weight	Sub-driver weight	Overall weight
1	Warehousing-related driver	Lack of storage infrastructure	0.5251	0.304	0.1596
2	Inventory management - related driver	Inaccurate forecasting	0.161	0.6633	0.1067
3	Warehousing-related driver	Lack of material handling equipment	0.5251	0.2026	0.1063
4	Warehousing-related driver	Poor storage handling	0.5251	0.1938	0.1017
5	Transportation-related driver	Logistics hold-ups	0.3139	0.2945	0.092
6	Transportation-related driver	Improper transportation conditions	0.3139	0.2884	0.090
7	Warehousing-related driver	Lack of cold storage infrastructure	0.5251	0.1637	0.085
8	Warehousing-related driver	Improper storage	0.5251	0.136	0.071
9	Transportation-related driver	Lack of cold chain equipment	0.3139	0.1547	0.049
10	Transportation-related driver	Poor transportation handling	0.3139	0.1504	0.047
11	Transportation-related driver	Transportation cost	0.3139	0.1121	0.035
12	Inventory management - related driver	Lack of stringent inventory policy	0.161	0.18	0.029
13	Inventory management - related driver	Poor order implementation	0.161	0.1567	0.025

Resource: Compiled by author

When the overall ranking table is examined, lack of storage infrastructure is the most prominent LCFLD which leads to the most loss in the upstream and midstream fruit and vegetable supply chain. Most of the time, freshly harvested fruits and vegetables are kept in the storage units for five or six months. So, if the storage infrastructure is not adequate, the stored products turn into waste. Inaccurate forecasting is the second LCFLD that causes the loss in the upstream and midstream fruit and vegetable supply chain. This sub-driver mainly cause food loss at the upstream. Unfortunately, in Turkey, no planning is provided in terms of agricultural production. Each year farmers grow fruit and vegetable-based on their preferences (unless they do not have contracts with companies) mainly based on the last year's sale. However, when all farmers adopt the same approach, next year there will be both surplus and lack of some type of food. Since the surplus food cannot be consumed on time, then loss occurs even at the land. Lack of material handling equipment is the third LCFLD that leads to the loss in the upstream and midstream fruit and vegetable supply chain.

Poor storage handling is the fourth LCFLD that cause a loss in the upstream and midstream fruit and vegetable supply chain. Storing is an essential function in fruit and vegetable supply chain because not all of the products grow in each season. Thus, storing them for 5 or 6 months is a universal application. However, poor storage handling dropping them while handling, put on top of each other, or harms caused by forklift usage damages the products, and damaged fruits and vegetables are rotten easily (Hussain et al., 2020). Logistics hold-ups are the fifth LCFLD that cause loss. As soon as the fruit or vegetable get harvested, it starts to lose value both in terms of nutrient and weight. Thus, any logistics hold-ups between post-harvest and processor/producers/wholesaler cause loss. Improper transportation condition is the sixth LCFLD that cause loss. Especially for products which have small fine-grains, they need to pre-packaged and then transported, or after the harvest products need to be transported in cool temperature regime to prevent weight loss. However, once these conditions cannot meet, then the loss occurs.

The LCFLD, which leads to the least loss is poor order implementation at the upstream and midstream fruit and vegetable supply chain. This is an expected result

because, in most cases, the order is processed by organizations which are tracked with systems.

5.3.5. Summary

AHP results revealed that the sub-driver which leads to more food loss is different for each supply chain. Table 63 reveals that the main sub-driver which cause food loss changes considering the food type. Table 63 shows the overall sub-driver rankings for each supply chain types altogether. For instance, according to experts' opinions, improper transportation sub-driver causes the highest amount of food loss for the upstream and midstream fats and oil supply chain. While logistics hold-ups cause the highest amount of food loss for the upstream and midstream milk and dairy supply chain. Experts' opinion revealed that improper storage causes the highest amount of food loss for the upstream and midstream meat and poultry supply chain. Lack of storage infrastructure leads to the highest amount of food loss for the upstream and midstream fruit and vegetable supply chain.

From these results, it can be deduced that to reduce food loss, specific solutions must be offered for each supply chain type. In the next chapter, solutions for each food supply chain was provided accordingly.

Table 63: Overall Ranking of LCFLDs for Upstream and Midstream

Ranking	Fats and Oil SC		Milk and Dairy Product SC		Meat and Poultry SC		Fruit and Vegetable SC	
	Sub-driver	Overall weight	Sub-driver	Overall weight	Sub-driver	Overall weight	Sub-driver	Overall weight
1	Improper transportation	0.227	Logistics hold-ups	0.2871	Improper storage	0.220	Lack of storage infrastructure	0.1596
2	Poor storage handling	0.123	Lack of cold storage infrastructure	0.1215	Lack of stringent inventory policy	0.141	Inaccurate forecasting	0.1067
3	Inappropriate shelf space	0.112	Improper storage	0.1032	Lack of cold storage infrastructure	0.132	Lack of material handling equipment	0.1063
4	Lack of cold storage infrastructure	0.108	Lack of cold chain equipment	0.0990	Poor order implementation	0.101	Poor storage handling	0.1017
5	Lack of cold chain equipment	0.096	Poor storage handling	0.0886	Inappropriate package size	0.083	Logistics hold-ups	0.092
6	Poor transportation handling	0.085	Inappropriate shelf space	0.0681	Inaccurate forecasting	0.081	Improper transportation conditions	0.090

7	Inaccurate forecasting	0.072	Poor transportation handling	0.0555	Suboptimal use of packaging functions	0.067	Lack of cold storage infrastructure	0.085
8	Improper handling equipment	0.056	Lack of stringent inventory policy	0.0493	Poor storage handling	0.051	Improper storage	0.071
9	Lack of stringent inventory policy	0.049	Lack of material handling equipment	0.0432	Inappropriate secondary packaging	0.029	Lack of cold chain equipment	0.049
10	Poor order implementation	0.037	Inaccurate forecasting	0.0431	Lack of cold chain equipment	0.027	Poor transportation handling	0.047
11	Lack of material handling equipment	0.034	Poor order implementation	0.0410	Poor transportation handling	0.026	Transportation cost	0.035
12					Improper transportation conditions	0.023	Lack of stringent inventory policy	0.029
13					Logistics hold-ups	0.019	Poor order implementation	0.025

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CHAPTER VI

CONCLUSION

6.1. GENERAL DISCUSSION AND THEORETICAL CONTRIBUTION

The first objective of this thesis was to identify which stakeholders have more salience while tackling with the food supply chain. To fulfil this objective, both primary and secondary data were employed; while, as a theoretical lens, stakeholder identification and salience theory were adopted. Secondary data was obtained via systematic literature review and analyzed with content analysis. To obtain primary data semi-interviews were conducted. The main purpose of conducting these semi-structured interviews was to ensure that the results of content analysis are also valid for Turkey and to see whether there is a specific stakeholder(s) take parts in the different food supply chains. Semi-structured interviews were analysed with thematic analysis. Moreover, to classify stakeholder groups according to salience, a stakeholder attribution chart was completed by the interviewees. The data collected from the charts were analyzed according to Tsoufas et al. (2019)'s method, and the Venn diagram was created based on the results. Lastly, to show the relationship of stakeholders, the framework for each food supply chain was provided.

Both qualitative and quantitative analysis results revealed that some stakeholders are present in almost all food supply chains such as suppliers, processors, packaging companies, wholesalers, retailers and consumers. Although they are doing the same tasks, some of these stakeholders were named differently. For instance, food processors, primary processor, first level manufacturer were used interchangeably in the literature (Rantavaara et al. 2005; Van der Vorst, 2005; Jaffee et al., 2010; Leat et al., 2011; Erdem et al., 2012; Rediers et al., 2012; Schiefer and Deiters, 2013; Verhofstadt and Maertens, 2013; Halloran et al., 2014; Tsolakis et al., 2014; LeBlanc et al., 2015; Parwez, 2016; Yan and Xu, 2016; Arivazhagan et al., 2017; Busse et al., 2017; Canali et al., 2017; Gjokaj et al., 2017). Similarly, stakeholders such as food manufacturers, secondary processors, and second level manufacturers can be used interchangeably (Sodhi and Tang, 2008; Kumar and Nigmatullin, 2011; Schiefer and Deiters, 2013; Bourlakis et al., 2014; Tsolakis et al., 2014; Canali et al., 2017). In

addition to these stakeholders, stakeholders such as logistics service providers (LSPs) are an important intermediary which serve between all stakeholders.

When the overall classifications across the different supply chains are examined, some commonalities have been identified. For instance, in each food type, the first step of the supply chains' (farmers, dairy farmers, animal farmers/coops) are classified as high salient stakeholders, parallel to the literature (Blue, 2016; Tsoulfas et al., 2019; Pedrosa-Ortega et al., 2019). However, the studies conducted for agriculture supply chain. Thus, classifying dairy farmers and animal farmers/coops are conducted for the first time in the literature to the best knowledge of author. Classification of farmers' as high salient is expected because, farmers (primary producers) have sanction power on the processors. Thus, most of the time, processors guarantee themselves with creating contractual relationships with them (Blue, 2016). In fact, primary producers are so powerful in some cases, their raw material quality affect the export of the finished products. Thus, for long time, milk processors could not export their finished products, and for the same reason, importing raw milk is not an acceptable implication.

Suppliers such as raw oil extraction facility, raw oil wholesaler, milk collection points, freshly harvested fruit and vegetable wholesalers are classified as high salient stakeholders. These stakeholders are important because in most case, food processors procure the raw foods from these stakeholder groups, and the quality of the products that are collected, sorted and sorted, affect the finished products' quality as well. This study is the first one that classifies these stakeholder groups in food supply chains in relation to food loss minimization.

Alongside the Pedrosa-Ortega et al. (2019) and Tsoulfas et al. (2019) researchers, food processors are classified as high salient stakeholders in this study. Another contribution of this study is classifying LSPs and traders (both exporters and importers). LSPs are classified as high salient stakeholders. This is expectable because LSPs operate between all stakeholders while considering products' characteristics. Traders, who import raw materials, are classified as high salient stakeholders. This result can be foreseen because the quality of imported raw materials affect the food security, food safety and hygiene and quality of the finished product. Because of this reason, importing raw milk is not encouraged in milk and dairy supply chain.

Wholesalers in the fats and oil supply chain and fruit and vegetable supply chain are classified as expectant stakeholders. As it is explained above, expectant stakeholder groups depends on the high salient stakeholders (Mitchell et al., 1997). With overlapping the SIST, wholesalers depend on the classified high salient stakeholders. However, for the milk and dairy supply chain and meat and poultry supply chain, wholesalers are classified as latent stakeholders. In both supply chain types, distribution of the finished products are competed by the agents of the firms. Thus, wholesalers are not preferred as much as in the oil and fruit and vegetable supply chain. Similarly, agents, who are generally owned by a parent company (food processor), are also classified as latent stakeholders. Agents are legitimate institutions but they are dependent on the parent companies. Similar to agents and wholesalers, traders, who export the finished products, are also classified as latent stakeholders.

The second objective of the thesis was to identify and classify logistics-related food loss drivers. To accomplish this objective, both primary and secondary data were employed; while as a theoretical lens theory of critical success factors were adopted. Secondary data were acquired from the systematic literature review and extracted articles were examined via content analysis. To obtain primary data semi-structured interviews were conducted. The prioritization of the interviewee selection was based on the salience of the stakeholder group. In case of where a necessity contact cannot be found, then a lower salience stakeholder group was included to interview process. The main purpose of conducting these semi-structured interviews is to ensure that the results of content analysis are also valid for Turkey and to see whether there are other food loss drivers, which are unique to Turkish FSCs' occur. The collected data from semi-structured interviews were analyzed with thematic analysis. Classification of the LCFLDs was completed with both using thematic analyses.

Both qualitative and quantitative analysis results revealed that there are four logistics-related critical food loss drivers and twenty one logistics-related critical food loss sub-drivers were identified. However, the occurrence of both drivers and sub-drivers change according to FSC type. Although in the literature it has been mentioned that especially for the developing countries, inadequate transportation infrastructure is a primary reason for food loss, none of the experts did mention inadequate transportation infrastructure as loss driver for Turkish food supply chains. Thus, in this

study, inadequate transportation infrastructure was removed from the analysis. In addition, none of the experts identified improper conditions of storage as a food loss driver for Turkish food supply chains. Thus, improper conditions of storage were also removed from the LCFLDs list. Similarly, none of the interviewees mentioned any problems in terms of lack of communication. Interviewed experts mentioned that communication between members never stops. Moreover, conducted interviews revealed that improper handling equipment causes food loss in the fats and oil supply chain. Similarly, interviews revealed that a sub-driver which is under the packaging-related drivers impact the amount of loss in the meat and poultry industry. Thus, inappropriate secondary packaging was added as a sub-driver.

Interviews with industry experts from fats and oil industry revealed that in the upstream and midstream, food loss can be occurred due to three logistics-related drivers which are transportation-related, warehousing-related and inventory management-related drivers. Since raw oil is transported in bulk condition, its transportation condition is important. Experts revealed that when flexitanks are not used for transportation of the bulk raw oil, losses occur. In fact, even with the flexitanks, the loss can occur because of the improper handling equipment such as pipes and valves which are not at the industry standards. The processed butter and margarine products need to be transported in cool or cold temperature regime. Therefore, when there is not enough reefer trucks and containers to make the shipment, the form of the products get deteriorated. In such a case, a mix of oils can disassociate and the taste of the product changes. Although it is safe to consume in this condition, it is not preferred by the consumers. So, the refinery needs to either re-work the finished product or dispose of it. The package of the products gets damaged if the products are not handled carefully during transportation, such as not stabilizing the pallets inside the transportation unit.

Lack of cold storage infrastructure becomes prominent especially for the midstream and the rest. The finished products need to be stored in cool temperature regime and when they cannot be stored in these type of storage units, the form of the product altered. Similar to poor transportation handling, poor storage handling is also LCFLD which cause a loss in the upstream and midstream fats and oil supply chain. When the pallets are dropped or the knives of the forklifts stuck products, the products

cannot be used. In this case, the damaged products are needed to either rework or dispose of. Inappropriate shelf spaces cause a loss in both at the warehouse and at retailer shelves but as the scope of this study, we only focus on inappropriate shelf spaces in the warehouses. When there is not enough space for storing products, the pallets can be put on top of each other which leads to crushes on the packages, and since customers have strict appearance rules about the packaged products, they will not prefer to buy and products become loss (de Hooge et al., 2017). Lack of warehousing equipment is another LCFLD which cause loss. The finished products are delicate and not durable for joggles. Forklifts and gears enable to carry more products within a short period of time with fewer joggles. Thus, having not enough warehousing equipment cause loss (Canali et al., 2017).

Interviews with industry experts from milk and dairy products revealed that food loss can occur in the upstream and midstream supply chain due to three logistics-related food loss drivers, which are transportation-related, warehousing-related and inventory management-related drivers. Logistics hold-ups cause food loss in the upstream milk and dairy supply chain. Raw milk needs to be processed within 48 hours once it is produced. Therefore, any delays in the transportation of raw milk impact the quality of produced milk and increase the contamination risk. Both raw milk and processed milk and dairy products need to be transported and stored in a cool or cold temperature regime. Thus, any deficiency of cold chain equipment such as lack of reefer trucks or containers and deficiency of cold storage infrastructure such as not enough space in the display freezers cause loss. Because once the cool or cold temperature regime breaks during transportation or storage the product shelf life decreases and the possibility of contamination increases (Wu et al., 2018).

Poor handling activities at both transportation and storage cause food loss in the upstream and midstream supply chain. For instance, during transportation pallets and boxes needs to be stabilized inside the transportation unit to eliminate joggles. When the pallets fall or forklift knives stick the products during storing, products' packages can get damaged or get contaminated and products need to be destroyed. Piling up boxes on top of each other cause more weight pressure for the products which are located at the bottom and as a result they might be smashed. If leakage occurs from the bottom packages that means that it lost its protective characteristics and the

products get contaminated. In this case, the product needs to be destroyed. Even if there is no leakage occurs but the packages get damaged in this case the products will not be preferred by consumers and eventually turn into waste. Having not enough shelf space on warehouses is another food loss driver. During the loading and unloading, the lack of material handling equipment such as forklifts can cause food loss in the upstream and midstream supply chain because milk and dairy products need to be transported and stored in cold temperature regime. Material handling equipment enables fast transshipment of the products from one place to another for instance from cold storing unit to cold transportation unit. However, when the handling equipment is missing, the transshipment process will increase. And as the time increases for the product to be stored outside of the cold storage, the risk of contamination also increases.

Except for UHT milk, the rest of the dairy products have a short shelf life. Thus, poor ordering implementation causes food loss in the upstream and midstream milk and dairy supply chain. The excessive products need to be returned to the processor, to conduct tests for ensuring no contamination or spoilage occurs during the transportation. However, this situation shortens the shelf life of the product and generally, in Turkey, it is not preferred to buy short shelf-life milk and dairy products. Thus, the products which remain on the shelves, become waste at the end.

Interviews with industry experts from meat and poultry industry revealed that food loss can occur in the upstream and midstream supply chain due to four logistics-related food loss drivers, which are transportation-related, warehousing-related, inventory-management related and packaging-related drivers. Raw meat and poultry products are transported alive to the processor from the animal farm or coop. If the live animals do not transport with proper conditions, animals get stressed and start to lose weight and the quality of the meat decreases. For both live animals and processed fresh meat products logistics hold-ups cause food loss. After loading of the live animals is completed, the shipping must be completed as soon as possible. However, after completing the loading of live animals to transportation unit, any logistics hold-ups, which cause delays in transportation increase the stress level of the livestock because animals spend more time than actually it is expected.

Export of fresh meat products is enabled with air transportation. However, during this export, the products generally transshipped without reefer containers with solely dry ices and thermal blankets. In these conditions, fresh meat products can hold on until the destination point however any delays will jeopardize the entire batch. Thus, lack of cold chain equipment and logistics hold-ups cause food loss in the upstream and midstream meat and poultry supply chain. In airports, processed fresh meat products wait in hangars until the boarding starts. Because in most airports, there is not enough cold storage capacity or not at all. So, if a delay occurs for the flight, the risk of spoilage for fresh meat products increase.

Poor transportation handling causes food loss especially during export of fresh meat products. As it is explained above, during the export of fresh products with air transportation, reefer containers are not preferred, instead shipment is prepared with dry ice and thermal blankets. LSPs request a certain amount of fresh product and dry ice amount for each shipment (for every eleven kilos of product one kilo of dry ice must be placed inside the boxes). However, to increase the product amount, shipper sometimes put less dry ice and add more product. In those circumstances, and if a delay occurs, the cold temperature regime is broken and products get contaminated, and the products need to be destroyed. Meat and poultry products' are packaged with delicate materials, and they are sensitive to strikes. Thus, any extra movement impacts the material of the package and can end up with tearing. The package size becomes a problem, especially for the whole chicken products. Although the chickens are separated according to their sizes, in the same size range, the size of the whole chicken can vary. In these cases, when the different sized whole chicken is put into the packages, the package is torn. If the torn package is detected at that processor, the product can be reworked. However, if it is not detected, it will be contaminated and needs to be destroyed or since the damaged packaging products are not preferred by the consumers, it will eventually turn into wastage. Secondary packaging of the meat and poultry products are also sensitive, and not very durable for strikes and moist. Thus, in any temperature changes affect the secondary packaging of the product.

For fruit and vegetable upstream and midstream supply chain, food loss occurs due to three logistics-related food loss drivers which are transportation-related, warehousing-related and inventory management-related drivers. Freshly harvested

fruit and vegetable products need to be transported in the right conditions. For instance, fine-grain products need to be transported with appropriate packaging to eliminate falling from the transportation unit. Logistics hold-ups is another LCFDL which cause a loss in the upstream and midstream fruit and vegetable supply chain. Freshly harvested products start to lose weight and nutritional value as soon as they are harvested (FAO, 1989). Thus, firms, which are going to process fruit and vegetables, want to produce fruits and vegetables within the day they are harvested. Thus, any delays or logistics hold-ups cause nutritional value loss, which is a type of food loss (Göbel et al., 2015). High transportation costs lead to loss in the upstream fruit and vegetable supply chain, especially in the production stage. Sometimes, the cost of transporting freshly harvested products to market the processor can be higher than the income which product brings when it is sold. In these cases, farmers prefer to leave the products unharvested at the field. In this case, the entire products on the field turn into waste (Chauhan et al., 2018).

Fresh fruits such as strawberry and cherry spoil very fast, thus for export of these products air transportation is preferred. However, during air transportation, reefer containers are not preferred by the shippers. Because it is not commonly preferred and the cost is expensive. Shippers need to ensure cool temperature regime with traditional methods such as dry ice and usage of thermal blankets. Thus, the lack of cold chain equipment increases the risk of spoilage of fresh fruits and vegetables. Poor handling activities during both storage and transportation cause loss in the upstream and midstream fruit and vegetable supply chain. Freshly harvested fruits and vegetables are sensitive to strikes. When the handling takes place poorly and when the products are exposed to joggles, this situation causes injuries on the surface of fruits and vegetables and once the fruits and vegetables get bruises, they spoil more easily (Hussain et al., 2020). Thus, finished products must be stabilized inside the transportation unit before transportation and products need to be stored with minimum strikes. In the fruit and vegetable industry, it is quite common to store products up to 5- 6 months in storage and then sell it. However, when the storage infrastructure is not suitable for storing products so long due to the various factors such as being moist, exposing sunlight, etc., the products will deteriorate. In addition, since the products stored so long, it is important to have enough storage infrastructure for all products.

Depending on the type, fruits and vegetable can grow between less than a months to up to a year (Devries, 2017). Thus, before processing starts, processors and manufacturers generally make contracts with the producers (farmers) or importers. However, when the yearly forecasts are not calculated correctly, this will lead to either raw fruit and vegetable shortage or an excessive amount of raw fruit and vegetable. Fresh fruit and vegetables can easily deteriorate. Because of poor ordering implementation such as ordering an excessive amount of product and cannot sell/consume on time, the excessive product turns into a loss.

The third objective of the thesis was to rank the LCFLDs, which have a higher impact on the waste amount, for reducing the overall food loss. To comply with this objective, the AHP method was employed. The experts that completed the AHP questionnaire was chosen based on the salience level of the stakeholder groups. Although in each FSC, different number of drivers and sub-drivers cause loss in the upstream and midstream supply chain, it is essential to identify which has a more intensive impact on the loss amount. For this purpose, we employed the AHP method to rank all sub-drivers for each food supply chain type to identify which has a more intensive impact. Purposive sampling was used while selecting experts.

AHP results revealed that for upstream and midstream fats and oil supply chain, the most prominent logistics-related critical food loss sub-driver is improper transportation. Raw and finished oil is transported in bulk conditions during exporting and importing. Improper transportation conditions such as not using flexitank is an essential driver that causes a loss in massive amounts. Poor storage handling is the second sub-driver that leads to loss. Dropping the pallets or flexitanks, sticking the forklift forks to products is the second sub-driver which leads to most loss in the upstream and midstream supply chain (Canali et al., 2017). Inappropriate shelf space is the third sub-driver that leads to loss. When the shelf space is not suitable for the bottled products, wholesalers store these products put on top of each other and which leads to crash in glass bottle products or smash in plastic bottle products (Mena et al., 2011). Once the glass bottle is broken, it cannot be used or reworked again due to safety reasons.

Similarly, when there is not enough space in the display fridge, the products which need to be stored in the cool temperature regime can stay out, and products

deteriorate. Lack of cold storage infrastructure is the fourth logistics-related food loss sub-driver that leads to loss in the upstream and midstream fats and oil supply chain. Butter and margarine require cool temperature regime while transportation and storage (Ma et al., 2015; Porat et al., 2018). For this reason, when the cold chain infrastructure is not adequate, the products melt and lose its form. Lack of cold chain equipment is the fifth LCFLD. Not having reefer containers while importing and exporting the products which require cool or cold chain transportation, and not having refrigerated trucks while distributing the finished products lead to food loss. Poor transportation handling is the sixth LCFLD that leads to food loss in the fats and oil upstream and midstream supply chain. If the products are not stabilized inside the transportation unit, the possibility of getting damaged of the products are quite high (Mena et al., 2011; Mazoncco et al., 2016).

AHP results revealed that for upstream and midstream milk and dairy product supply chain, the most prominent logistics-related critical food loss sub-driver is logistics hold-ups. The raw milk needs to be processed within 48 hours. So, if there is a delay occurs at the delivery of the raw milk, the possibility of spoilage of the raw milk increases. Lack of cold storage infrastructure is the second LCFLD that leads to a loss in the upstream and midstream milk and dairy product supply chain. Except for UHT milk, daily milk and dairy products need to be stored in cool temperature regime. The products which are left out outside of the cold storage will be spoiled (Chauhan et al., 2018; Stangherlin and de Barcellos, 2018). Improper storage is the third LCFLDs that lead to the loss in the upstream and midstream milk and dairy supply chain. Especially, when the products are put on top of each other, this storing causes damage to the package such as leakage on the packages or crushes (Willersinn et al., 2015; Irani and Sharif, 2016; Canali et al., 2017). Since consumers have strict appearance requests about the food products, these damaged packaging products cannot be sold, and eventually, they turn into waste (de Hooge et al., 2017). Poor storage handling is the fifth LCFLD that cause a loss in the upstream and midstream supply chain. Primarily, accidents occurred during the loading and unloading the storage units cause loss. Dropping pallets or sticking the forklift knives to products also cause loss at the warehouses (Canali et al., 2017).

AHP results revealed that for upstream and midstream meat and poultry supply chain, the most prominent LCFLD is improper storage. The packaging of the meat and poultry and especially poultry product is relatively delicate for impact and weights. When the products are stored improperly, the packaging of the products can be damaged in easily. Lack of stringent inventory policy is the second LCFLD that leads to the loss in the upstream and midstream meat and poultry supply chain. Most of the meat and poultry products have short shelf life mainly less than a week. So, especially when the firms do not have regular and stringent inventory policies, this leads to loss for the companies in the upstream and midstream supply chain (Lebersorger and Schneider, 2014; Ma et al., 2015; Irani and Sharif, 2016). Because in most case companies in the downstream try to buy more or order more product than actually, they can sell to get discount, so when they cannot sell the products on time, they ask the producer or agents to relocate the product. Since the bacteria can proliferate on meat and poultry product when the cold temperature chain breaks, the producer has to ensure that product does not contaminated, which also requires extra time. During all these processes, the shelf life of the product can pass, and in this case, producer either has to determinate or freeze the product.

Lack of cold storage infrastructure is the third LCFLD. All meat and poultry products are sensitive to temperature, and they need to store in cool, cold or frozen temperature regime. Thus, any shortage of cold storage facility cause loss because even in the temperature changes, the risk of contamination increases abruptly (FAO, 1991; Stangherlin and de Barcellos, 2018; Porat et al., 2018). Poor order implementation is the fourth LCFLD that cause loss. Especially wrong product ordering is the main reason for this driver. Although the wrong products are collected immediately, before redistribution, products have to return the processor and needs to be tested for contamination. This is a long process for a product with a shelf life of approximately 5 days. Thus, in this case, most of the time products have to be destroyed.

Inappropriate package size is the fifth LCFLD that lead to a loss in the upstream and midstream meat and poultry supply chain. The package size becomes a problem, especially for the whole chicken products. Although the chickens are separated according to their sizes, in the same size range, the size of the whole chicken can vary. In these cases, when the different sized whole chicken is put into the packages, they

tear the package. Since the consumers do not prefer damaged packaging, the product becomes waste. Inaccurate forecasting is the fifth LCFLD. Because companies forecast their sales at the beginning of the fiscal year and once they plan and contract with their supplier for throughout the year, it is difficult for companies to adjust production plans (Tropm et al., 2016; Beausang et al., 2017; Canali et al., 2017). Suboptimal use of packaging functions is the sixth LCFLD which leads to a loss in the upstream and midstream supply chain. Using delicate packaging material makes the finished product to more vulnerable to impacts (Manzocco et al., 2016; Priefer et al., 2016; Thyberg and Tonjes, 2016; Arivazhagan et al., 2017; Canali et al., 2017).

AHP results revealed that for upstream and midstream fruit and vegetable supply chain, the most prominent LCFLD is lack of storage infrastructure. When the overall ranking table is examined, lack of storage infrastructure is the most prominent LCFLD which leads to the most loss in the upstream and midstream fruit and vegetable supply chain. Most of the time, freshly harvested fruits and vegetables are kept in the storage units for five or six months (Gogo et al., 2018). So, if the storage infrastructure is not adequate, the stored products turn into waste (Balaji and Arshinder, 2016). Inaccurate forecasting is the second LCFLD that causes the loss in the upstream and midstream fruit and vegetable supply chain. This sub-driver mainly cause food loss at the upstream. The results show that more planning is required in terms of agricultural production. Each year farmers grow fruit and vegetable-based on their preferences (unless they do not have contracts with companies) mainly based on the last year's sale. However, when all farmers adopt the same approach, next year there will be both surplus and lack of some type of food. Since the surplus food cannot be consumed on time, then loss occurs even at the land. Lack of material handling equipment is the third LCFLD that leads to the loss in the upstream and midstream fruit and vegetable supply chain.

Poor storage handling is the fourth LCFLD that cause a loss in the upstream and midstream fruit and vegetable supply chain. Storing is an essential function in fruit and vegetable supply chain because not all of the products grow in each season. Thus, storing them for 5 or 6 months is a universal application (Gogo et al., 2017; Gogo et al., 2018). However, poor storage handling dropping them while handling, put on top of each other, or harms caused by forklift usage damages the products, and damaged

fruits and vegetables are rotten easily (Hussain et al., 2020). Logistics hold-ups are the fifth LCFLD that cause loss. As soon as the fruit or vegetable get harvested, it starts to lose value both in terms of nutrient and weight (Göbel et al., 2015). Thus, any logistics hold-ups between post-harvest and processor/producers/wholesaler cause loss. Improper transportation conditions are the sixth LCFLD that cause loss. Especially for products which have small fine-grains, they need to be pre-packaged and then transported, or after the harvest products need to be transported in cool temperature regime to prevent weight loss. However, once these conditions cannot meet, then the loss occurs.

6.2. PRACTICAL IMPLICATIONS

The results of this study provide several implications for practitioners. Both identification and classification of CUMSs and LCFLDs revealed that “one size fits all” approach does not work for FSCs. So, to reduce food loss amount, specific suggestions must be offered for each food supply chain.

To reduce the food loss amount in the fats oil supply chain, the following suggestions can be implemented. During the bulk transportation of raw and finished oil, flex tanks can be employed. The quality of the valves which are used for loading and unloading of the flexi tanks, must be good for preventing leakages. For bottled products, shelf space adjustments needs to be done carefully. Cold storage infrastructure needs to be enhanced in terms of capacity. Maintenance of cold storage and handling equipment needs to be conducted regularly. Advanced IT software must be utilized to solve inventory management-related problems. Trainings must be offered to employees for handling, loading and unloading of the products. In addition to that, trainings must be offered both white and blue collar employees to increase the awareness about food loss.

To reduce the food loss amount in the milk and dairy product supply chain, the following suggestions can be implemented. Logistics related delays must be eliminated. This elimination can be achieved with increasing internal process and/or strong communication. Blockchain technology can be employed to solve inventory management-related problems. For bottled products, shelf space adjustments needs to

be done carefully. Cold storage infrastructure needs to be enhanced in terms of capacity. Maintenance of cold storage and handling equipment needs to be conducted regularly. Trainings must be offered to employees for handling, loading and unloading of the products. In addition to that, trainings must be offered both white and blue collar employees to increase the awareness about food loss.

To reduce the food loss amount in the meat and poultry supply chain, the following suggestions can be implemented. The conditions of airport hangars should be improved. Because currently LSPs or airlines cannot guarantee temperature regimes for products which requires storing and transporting at certain temperature regimes. Shippers has to ensure cool or cold temperature regimes with dry ice and thermal blankets. In addition, the reefer container utilization can be expanded for air transportation. Since meat and poultry industry deals with food loss due to packaging related issues, a collaboration can be conducted with packaging supplier. Similarly, to diminish the food loss amount, meat and poultry producers can collaborate with LSPs especially for air transportation. Cold storage infrastructure needs to be enhanced in terms of capacity. Maintenance of cold storage and handling equipment needs to be conducted regularly. Trainings must be offered to employees for handling, loading and unloading of the products. In addition to that, trainings must be offered both white and blue collar employees to increase the awareness about food loss.

To reduce the food loss amount in the fruit and vegetable supply chain, the following suggestions can be implemented. The conditions of the storages must be improved. Capacity of storage must be increased or used more efficiently. Transportation must be arranged according to product type, grain products need to be carried within big bags or boxes. Trainings must be offered to employees for handling, loading and unloading of the products. In addition to that, trainings must be offered both white and blue collar employees to increase the awareness about food loss. Moreover, special trainings must be offered for farmers to adopt new technologies for planting and harvesting. Digitalization must be implemented for solving inventory management-related problems.

In addition to these industry specific suggestions, suggestions can also be provided to policy makers. Utilization of Industry 4.0 technologies can help to reduce food loss. For instance, with the utilization of drone technologies and automation, the

amount of loss can be decreased in production. In addition, big data analysis can be employed in planning the production, which helps to diminish the food loss amount due to excessive production. Moreover, with the help of Industry 4.0, IoT and digitalization, manufacturing processes becomes more waste free. With popularizing closed production systems, the loss of food can be minimized.

Government can offer initiative to producers and processors to be waste free. Food unions and associations can go into the effort of being waste free. These groups can offer trainings to farmers, producers and processors. This thesis revealed that diminishing food loss is a complex issue which requires combining different logistics related solutions. Thus, to achieve this complex task, 4PLs can specialize on providing solutions for food loss. Collaborations must be encouraged between producers and manufacturers with food banks.

6.3. LIMITATIONS AND DIRECTIONS FOR FURTHER RESEARCH

The study has some limitations, which also provides new research ideas for future studies. First of all, due to the scope of the food loss, this study was only focused upstream and midstream supply chain activities, and excluded retailers, food services and households. Thus, future studies can be conducted about retailers and food services and what are the logistics-related drivers that cause waste in these stakeholders. Moreover, another study can be conducted on households and consumers storing, and taking food to home behavior on consumers.

Second, the proposed model can be replicated with larger sample to test the external validity, possibly with including other supply chains such as fishery or with more stakeholders from the four supply chains.

Third, the theoretical underpinning of this research was ensured by employing two theories. However, different theories can also be utilized to investigate this phenomenon. Thus, in future different theories can be implied for tackling with food loss.

Another limitation of the study is about sampling. During the interviews, only one person was interviewed from one company. More balanced number of responded between different sectors would be more desirable. However, the number of

companies in the selected sectors is not evenly distributed which made it complicated to reach the same amount of respondents from each sector. Nonetheless, utmost attention is paid to conduct AHP survey with the leading companies in each sector to achieve representativeness of the sample. Thus, another study can be conducted by interviewing people from different positions in the same company.

This research provides important understandings for future research as well. First, a study can be conducted on by focusing a specific product such as potato, tomato, etc. and the processes of the product from farm to fork can be examined and whole points which cause loss and waste can be identified. Second, a study can be conducted on retailer industry to identify drivers that cause waste. Third, similar to retailers, a study can be conducted on food services to identify food waste drivers and consumer behaviors that lead to waste in the industry. Fourth, households are another important source of waste, and food become waste due to behavioral reasons. Currently, there is no study conducted on household food waste behaviors in Turkey. So, conducting such a study will definitely be an important contribution to the literature. Fifth, diminishing food loss is a complex issue which requires collaboration of different disciplines. Thus, multidisciplinary studies can be conducted on this phenomenon. Sixth, studies can be conducted with different methodologies such as system dynamics and network optimization. Seventh, a study can be conducted on solely focusing a specific product such as potato, tomato, fresh meat, etc.

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APPENDICES

APPENDIX 1. Interview Questions for Stakeholder Identification

This study was prepared within the scope of the doctoral thesis of Ebru SÜRÜCÜ BALCI, who is doing her doctorate at Dokuz Eylül University, Institute of Social Sciences.

This interview questions for upstream and midstream fruit and vegetable food supply chain members operating in the food sector in Turkey. The obtained answers will not be used outside of academic activities. None of the company and personal information will be shared in this study.

Thank you for your participation.

Research Assist. Ebru SURUCU BALCI

Prof. Dr. Okan TUNA

Demographic questions (interviewee):

1. Current position:
2. Experience in the current firm (years):
3. Experience in the food industry (years):

Demographic questions (firm):

1. Date of establishment:
2. The number of personnel:
3. Income:
4. Which sector(s) are you operating? (1. meat and poultry products, 2. milk and dairy products, 3. patisserie, 4. fruit and vegetables, 5. ready-packaged foods, 6. cereals, flour, starch, 7. fats and oil)
5. Do you have a food safety certificate? (such as ISO 22000)
6. Do you have a logistics department?
7. Do you use information packaging systems such as SAP for order management or logistics activities?
8. What is the monthly production/sales/export/import amount? (tons, money, TEU)

QUESTIONS:

1. Who are the initial supplier of fruit and vegetable supply chain?
2. Who are your suppliers?
3. Who are your customers?
4. Do you think that your suppliers deal with food loss in their facilities?
5. Do you think that farmers deal with food loss in their facilities?
6. Do you think that agricultural cooperatives (farm associations) deal with food loss?
7. Do you think that traders who import, deal with food loss?
8. Do you think that traders who export, deal with food loss?
9. Do you think that food processors (primary processors or first level manufacturers) deal with food loss?

10. Do you think that food manufacturers (secondary processors or second level manufacturers) deal with food loss?
11. Do you think that packaging companies deal with food loss?
12. Do you think that distributors deal with food loss?
13. Do you think that wholesalers deal with food loss?
14. Do you think that LSPs deal with food loss?
15. Do you collaborate with any research center or institutions? If so, do you think that research center and institutes deal with food loss?
16. Do you collaborate with any financial institution (banking)? If so, do you think that financial institutions deal with food loss?
17. Do you think that unions deal with food loss?
18. What are the regulations/processes that you need to comply with that is regulated by the government?
19. What are the regulations/processes that you need to comply with that is regulated by the policy makers/regulators?



APPENDIX 2. Stakeholder Attribution Chart Sample (for Fruit and Vegetable)

This study was prepared within the scope of the doctoral thesis of Ebru SÜRÜCÜ BALCI, who is doing her doctorate at Dokuz Eylül University, Institute of Social Sciences.

This stakeholder attribution chart is prepared to classify upstream and midstream fruit and vegetable supply chain stakeholders according to their salience level. The obtained answers will not be used outside of academic activities. None of the company and personal information will be shared in this study.

Thank you for your participation.

Research Assist. Ebru SURUCU BALCI

Prof. Dr. Okan TUNA

As a result of the examination of previous studies and interviews with industry experts, 8 stakeholders were identified as upstream and midstream fruit and vegetable supply chain members who deal with food loss. **You are expected to give points from 0 to 4 based on their attribute possession.**

- 0** means stakeholder **does not have any possession** for the attribute.
- 1** means stakeholder has **a low level of possession** for the attribute.
- 2** means stakeholder has **a medium level of possession** for the attribute.
- 3** means stakeholder has **a high level of possession** for the attribute.
- 4** means stakeholder has **a very high level of possession** for the attribute.

In theory, a stakeholder can have one of these attributes which are power, legitimacy and urgency.

Power is defined as the extent to which a party has or can gain access to physical, material or prestige, esteem and social means to impose their will.

Legitimacy is defined as generalized perception or assumption that the actions of an entity are desirable, proper or appropriate within some socially constructed system of norms, values, beliefs and definitions.

Urgency is defined as the degree to which stakeholder claims call for immediate attention.

Please complete the attribution chart based on the provided information.

	Power	Legitimacy	Urgency
Agricultural farmer			
Trader (import)			
Freshly harvested fruit and vegetable wholesaler			
Market hall			
Fruit and vegetable processor			
Food manufacturer			
Trader (export)			
Wholesaler			

Demographic Questions.

- Current position in the company:
- Employment time in the current company (year):
- Total employment time in food industry (year):
- In which area, does your company operate (you can select more than one option)
 - ☐ Fresh fruits and vegetable export
 - ☐ Fresh fruits and vegetable import
 - ☐ Frozen fruits and vegetable export
 - ☐ Frozen fruits and vegetable import
 - ☐ Dried fruits and vegetable export
 - ☐ Dried fruits and vegetable import
 - ☐ Canned fruit and vegetable export
 - ☐ Canned fruit and vegetable import
 - ☐ Other (please specify):
- Indicate the food safety certificates that your company has (you can select more than one option)
 - ☐ AHA ☐ HACCP
 - ☐ ISO22000
 - ☐ ISO 28000

☐ IFS

☐ BRC

☐ Other (please specify):

6. You can answer according to the unit that is most convenient for you from the following options.

What is the monthly production (export/import/sales) amount (tons):

What is the monthly production (export/import/sales) amount (money):

What is the monthly production (export/import/sales) amount (tons) (TEU):

Thank you for participating in our survey.



APPENDIX 3. Interview Questions for LCFLDs Identification

This study was prepared within the scope of the doctoral thesis of Ebru SÜRÜCÜ BALCI, who is doing her doctorate at Dokuz Eylül University, Institute of Social Sciences. This interview questions for food manufacturers operating in the food sector in Turkey, suppliers, processors, manufacturers, LSPs, wholesalers, and retailers. The obtained answers will not be used outside of academic activities. None of the company and personal information will be shared in this study.

Thank you for your participation.

Research Assist. Ebru SURUCU BALCI

Prof. Dr. Okan TUNA

Demographic questions (interviewee):

4. Current position:
5. Experience in the current firm (years):
6. Experience in the food industry (years):

Demographic questions (firm):

9. Date of establishment:
10. The number of personnel:
11. Income:
12. Which sector(s) are you operating? (1. meat and poultry products, 2. milk and dairy products, 3. patisserie, 4. fruit and vegetables, 5. ready-packaged foods, 6. cereals, flour, starch, 7. fats and oil)
13. Do you have a food safety certificate? (such as ISO 22000)
14. Do you have a logistics department?
15. Do you use information packaging systems such as SAP for order management or logistics activities?
16. What is the monthly production/sales/export/import amount? (tons, money, TEU)

Product-related questions:

1. Can you describe your product?
2. Can it be spoiled?
3. What is the shelf life of the product?
4. Is there any special requirement for storing the product?
5. Does the product require special temperature regime while transporting and storing?

QUESTIONS:

1. Describe your company's supply chain, from production to end customer.
2. Do you outsource any activities? Do you use a third-party logistics service provider in your logistics activities?
3. Does your company engage in logistics and transportation activities? If so, what are these activities? (location of warehouses, your warehouse, are the trucks yours, refrigerated, mode of transportation)
4. Do you keep statistics on food loss amount in your company? If so, how do you keep these statistics? (Money, weight, package, nutritional value)
 - 4.1. What is the average annual food loss? OR How much food loss had you experienced in the company last month?
5. Considering the supply chain you've just described, at which stages food loss occurs more? (Procuring, transportation, packaging, manufacturing, storing).
6. Do you experience food loss because of poor demand forecasting?
7. Do you experience food loss during shipments? (from supplier to you, into the warehouse) What could be the reasons for this loss?
8. Does there any food loss occur during storing? What could be the reasons for this loss?
9. Do you experience any food loss during the packaging/labelling of the product? What could be the reasons for this loss?
10. Do you experience food loss while ordering raw materials/ semi-finished products/finished products? What could be the reasons for this loss?
11. Do you experience food loss due to lack of communication? What could be the reasons for this loss?
12. Can you take advantage of this loss? (selling cheaper, donating animal shelter, use as fertilizers, recycle)
13. What can be done to minimize food loss in your facility?
14. What is the main motivation for your facility to minimize food loss?
15. Do you make any request to your partners to reduce their food loss? Do you receive such a request?
16. Are there meetings, seminars, social awareness events or workshops in your industry to tackle with loss?
17. In your opinion, what should be done to increase food security (with reducing food loss) considering your industry or other industries?
18. Is there a regulation/process that you need to comply with that is regulated by your chamber of commerce or by the ministry in regard to food loss?
19. Which countries do you export more? From which country, more requests come for ensuring food security? (Is there any regional difference?)

APPENDIX 4. AHP Questionnaire Sample (Fruit and Vegetable)

This study was prepared within the scope of the doctoral thesis of Ebru SÜRÜCÜ BALCI, who is doing her doctorate at Dokuz Eylül University, Institute of Social Sciences. The ultimate aim of the study is to reveal the importance of logistics-based factors that cause food loss in the fruit and vegetable sector. Accordingly, it is of great importance that you complete the survey. The obtained answers will not be used outside of academic activities. Neither their own nor the company information of any participant participating in the study will be shared.

Thank you for your help.

Research Assistant Ebru SÜRÜCÜ BALCI

Prof. Dr. Okan TUNA

As a result of the examination of previous studies and interviews with industry experts, 3 main criteria and 13 sub-criteria were determined. These criteria and sub-criteria will be asked to you in pair-wise comparisons as described in the examples below. You will be asked to mark which of the two criteria has the most significant effect on causing food loss and the degree of this importance.

Scoring scale to be used in the evaluation and general information about the use of this scale;

NUMERIC VALUE	EXPLANATION
1	Equal importance (Two activities contribute equally to the objective)
3	Moderate importance (Experience and judgement slightly favor one activity over another)
5	Strong importance (Experience and judgement strongly favor one activity over another)
7	Very strong importance (One activity is strongly favored over another)
9	Extremely important (The evidence favoring one activity over another is of the highest possible order of affirmation)
2,4,6,8	Intermediate values between the two adjacent judgments

Example 1

If you think that when comparing the criteria, both criteria cause same amount of loss in the supply chain, you should mark the number 1 in the middle as shown in the example.

Driver 1	Relative importance																		Driver 2
	1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance																		
Transportation-related drivers	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehousing-related drivers	
	☐	☐	☐	☐	☐	☐	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐		

Example 2

When comparing the criteria, if you think that the criterion on the left (transportation related-drivers) causes more amount of loss compared to the criterion on the right (warehousing-related drivers), you should mark on the left side of the scale. If you think that criterion on the left side has an absolute level of importance in terms of driving food loss amount, please mark 9. If you think that criterion on the left side has a very strong level of importance in terms of driving food loss amount, please mark 7. If you think that criterion on the left side has a strong level of importance in terms of driving food loss amount, please mark 5. If you think that criterion on the left side has a moderate level of importance in terms of driving food loss amount, please mark 3.

In the example below, the number 7 is marked on the left, as the transportation-related drivers are thought to cause a very strong level of food loss amount compared to warehousing-related drivers.

Driver 1	Relative importance																		Driver 2
	1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance																		
Transportation-related drivers	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehousing-related drivers	
	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐		

Example 3:

When comparing the criteria, if you think that the criterion on the right (warehousing-related drivers) causes more loss compared to the criterion on the left (transportation-related drivers), you should mark on the right side of the scale. If you think that criterion on the left side has an absolute level of importance in terms of driving food loss amount, please mark 9. If you think that criterion on the left side has a very strong level of importance in terms of driving food loss amount, please mark 7. If you think that criterion on the left side has a strong level of

importance in terms of driving food loss amount, please mark 5. If you think that criterion on the left side has a moderate level of importance in terms of driving food loss amount, please mark 3.

In the example below, the number 3 is marked on the right, as warehousing-related drivers are thought to cause a moderate level of food loss amount than the transportation-related drivers.

Driver 1	Relative importance																		Driver 2
1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance																			
Transportation-related drivers	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehousing-related drivers	
☐☐☐☐☐☐☐☐☐☐☐☒☐☐☐☐☐☐☐☐																			

Logistics-related main drivers

1. Transportation-related drivers
2. Warehousing-related drivers
3. Inventory management-related drivers

Compare the 3 main logistics-related food loss drivers that cause loss in the fruit and vegetable supply chain. (3 comparisons)

Main Driver 1	Relative importance																		Main Driver 2
1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance																			
Transportation-related drivers	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Warehousing-related drivers	
☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐																			

Main Driver 1	Relative importance																		Main Driver 3
1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance																			
Transportation-related drivers	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Inventory management-related drivers	
☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐																			

Main Driver 2

Relative importance

Main Driver 3

1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance

Warehousing-related drivers

9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9

Inventory management-related drivers

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Transportation-related sub-drivers

1. Improper transportation conditions
2. Logistics hold-ups
3. Transportation cost
4. Lack of cold chain equipment
5. Poor transportation handling

Compare the 5 transportation-related food loss sub-drivers that cause loss in the fruit and vegetable supply chain. (10 comparisons)

Sub-driver 1

Relative importance

Sub-driver 2

1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance

Improper transportation conditions

9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9

Logistics hold-ups

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Sub-driver 1

Relative importance

Sub-driver 3

1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance

Improper transportation conditions

9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9

Transportation costs

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

Sub-driver 1

Relative importance

Sub-driver 4

1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance

Improper transportation conditions	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Lack of cold chain equipment
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Sub-driver 1

Relative importance

Sub-driver 5

1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance

Improper transportation conditions	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Poor transportation handling
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Sub-driver 2

Relative importance

Sub-driver 3

1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance

Logistics hold-ups	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Transportation costs
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Sub-driver 2

Relative importance

Sub-driver 4

1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance

Logistics hold-ups	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Lack of cold chain equipment
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Sub-driver 2

Relative importance

Sub-driver 5

1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance

Logistics hold-ups	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Poor transportation handling
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐																		

Sub-driver 3	Relative importance																Sub-driver 4	
1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance																		
Transportation costs	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Lack of cold chain equipment
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐																		

Sub-driver 3	Relative importance																Sub-driver 5	
1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance																		
Transportation costs	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Poor transportation handling
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐																		

Sub-driver 4	Relative importance																Sub-driver 5	
1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance																		
Lack of cold chain equipment	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Poor transportation handling
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐																		

Warehousing-related sub-drivers:

1. Lack of storage infrastructure
2. Improper storage
3. Lack of cold storage infrastructure
4. Poor storage handling
5. Lack of material handling equipment

Compare the 5 warehousing-related food loss sub-drivers that cause loss in the fruit and vegetable supply chain (10 comparisons)

Sub driver 1	Relative importance	Sub driver 2
1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance		
Lack of storage infrastructure	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Improper storage
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐		

Sub driver 1	Relative importance	Sub driver 3
1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance		
Lack of storage infrastructure	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Lack of cold storage infrastructure
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐		

Sub driver 1	Relative importance	Sub driver 4
1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance		
Lack of storage infrastructure	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Poor storage handling
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐		

Sub driver 1	Relative importance	Sub driver 5
1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance		
Lack of storage infrastructure	9 8 7 6 5 4 3 2 1 2 3 4 5 6 7 8 9	Lack of material handling equipment
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐		

Sub driver 2	Relative importance	Sub driver 3

1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance

Improper storage	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Lack of cold storage infrastructure
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Sub driver 2

Relative importance

Sub driver 4

1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance

Improper storage	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Poor storage handling
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Sub driver 2

Relative importance

Sub driver 5

1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance

Improper storage	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Lack of material handling equipment
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Sub driver 3

Relative importance

Sub driver 4

1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance

Lack of cold storage infrastructure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Poor storage handling
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Sub driver 3

Relative importance

Sub driver 5

1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance

**inventory
policy**

☐	☐	☐	☐	☐	☐	☐	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐

Sub driver 2

Relative importance

Sub driver 3

1=Equal, 3= Moderate importance, 5= Strong importance, 7=Very strong importance, 9= Extremely importance

**Inaccurate
forecasting**

9 8 7 6 5 4 3 2 **1** 2 3 4 5 6 7 8 9 **Poor ordering
implementation**

☐	☐	☐	☐	☐	☐	☐	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐

Demographic Questions:

- Current position in the company:
- Employment time in the current company (year):
- Total employment time in food industry (year):
- In which area, does your company operate (you can select more than one option)
 - ☐ Fresh fruits and vegetable export
 - ☐ Fresh fruits and vegetable import
 - ☐ Frozen fruits and vegetable export
 - ☐ Frozen fruits and vegetable import
 - ☐ Dried fruits and vegetable export
 - ☐ Dried fruits and vegetable import
 - ☐ Canned fruit and vegetable export
 - ☐ Canned fruit and vegetable import
 - ☐ Other (please specify):
- Indicate the food safety certificates that your company has (you can select more than one option)
 - ☐ AHA ☐ HACCP
 - ☐ ISO22000
 - ☐ ISO 28000
 - ☐ IFS
 - ☐ BRC
 - ☐ Other (please specify):

6. You can answer according to the unit that is most convenient for you from the following options.

What is the monthly production (export/import/sales) amount (tons):

What is the monthly production (export/import/sales) amount (money):

What is the monthly production (export/import/sales) amount (tons) (TEU):

Thank you for participating in our survey.

